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**HAZARDOUS WASTE
RESEARCH AND INFORMATION CENTER**

**ANNUAL REPORT
MAY 1, 1986 - APRIL 30, 1987**



**Artist's rendition of HWRIC's Hazardous Materials Laboratory,
to be completed June, 1989**

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ANNUAL REPORT

May 1, 1986 - April 30, 1987

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ABBREVIATIONS

BNRC	Board of Natural Resources and Conservation
BOB	Bureau of the Budget
CDB	Capital Development Board
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DENR	Department of Energy and Natural Resources
EEA	Energy and Environmental Affairs
EEI	Envirodyne Engineering, Inc.
EMS	ethylmethane-sulfonate
GAO	Government Accounting Office
GIS	Geographic Information System
HML	Hazardous Materials Laboratory
HRS	Hazard Ranking System
HSWA	Hazardous and Solid Waste Amendments
HWRIC	Hazardous Waste Research and Information Center
IDOL	Illinois Department of Labor
IDOT	Illinois Department of Transportation
IDPH	Illinois Department of Public Health
IEPA	Illinois Environmental Protection Agency
IITRI	Illinois Institute of Technology Research Inst.
IPCB	Illinois Pollution Control Board
ITA	Industrial Technical Assistance
NHS	Natural History Survey
NPL	National Priority List
NSF	Net Assignable Square Footage
OSHA	Occupational Safety and Health Administration
OTA	Office of Technology Assessment
PAH	Polyaromatic hydrocarbons
PCBs	Polychlorinated biphenyls
RCRA	Resource, Conservation, and Recovery Act
RRT	Recycling, Recovery, and Treatment
SIC	Standard Industrial Code
SQG	Small Quantity Generator
SRAPL	State Remedial Action Priority List
SWS	State Water Survey
TCLP	Toxic Constituent Leaching Procedure
TSD	Treatment, Storage, and Disposal
UI	University of Illinois
USEPA	U.S. Environmental Protection Agency

HIGHLIGHTS

The Hazardous Waste Research and Information Center (HWRIC) was formed in 1984 within the Department of Energy and Natural Resources (DENR). It is located near the University of Illinois campus in Champaign-Urbana and is administered by the Illinois State Water Survey (SWS). This is the Center's second annual report and it covers the period May 1986 through April 1987.

The Center has been invested with specific objectives:

- reducing the volume of hazardous wastes generated and the threat they pose to human health and the environment,
- sponsoring research on hazardous waste issues of importance to Illinois,
- characterizing and assessing the extent of Illinois' hazardous waste problems,
- assembling, analyzing, and disseminating hazardous waste-related information and making it available to various groups and individuals,
- providing assistance to industry, agriculture, and communities,
- helping develop and implement a comprehensive hazardous waste management program for Illinois.

Many of the accomplishments of the last year have been in the development of specific Center priorities and programs, development of the design for the \$9 million Hazardous Materials Laboratory, and in the establishment of HWRIC as a viable and successful state program. The Center has also established itself on the national level. Working through the National Governors' Association and the United State Environmental Protection Agency (USEPA), HWRIC is coordinating its activities with ongoing federal programs and the programs of other states.

A. HWRIC MANAGEMENT

HWRIC works to achieve its objectives through its five closely linked programs: Research, Industrial and Technical Assistance, Information Services, Data Management and Laboratory Services. The Data Management program was established as a separate program in FY'87 to provide better support for the original three programs and the Hazardous Materials Laboratory, which is now in the design phase.

HWRIC's management structure is shown in Figures 1 and 2. A Policy and Program Governing Board, chaired by the SWS Chief, provides administrative supervision to the Director of the Center, and provides guidance for and approves the policy and programs of the Center. Since the SWS is under the Board of Natural Resources and Conservation (BNRC), HWRIC also reports to and receives direction from the BNRC though the SWS.

The Center also has two advisory committees: an Internal Research Advisory Committee composed of one scientist from each Division of DENR, and a Program Advisory Panel composed of representatives from industry, academia, citizens' groups, and state government. The former committee provides input and guidance to the Research

program of the Center; the latter group reviews the Center's programs and provides guidance as to future needs.

B. MAJOR HWRIC PROJECTS

HWRIC has identified four major projects as Center priorities:

- hazardous waste reduction,
- hazardous waste management by very small quantity generators,
- status and adequacy of the hazardous waste data base,
- hazardous waste education and training.

Waste Reduction Program

The Center's waste reduction program deals with an aspect of hazardous waste management that has gained national attention and focus. As part of HWRIC's overall waste reduction program, the Center:

- Provides technical assistance to industry to help them improve general housekeeping; recycle waste when appropriate, either internally or through material exchanges; propose and provide process modifications to reduce hazardous waste generation; detoxify waste; and substitute nonhazardous for hazardous materials.
- Is creating a technology transfer/clearinghouse data base on alternative technologies to be used by various industries and trade groups to reduce hazardous waste generation.
- Administers a matching fund program of up to \$100,000 to support industry in their efforts to modify existing equipment or processes, or to develop new technologies that minimize the generation of hazardous waste.
- Encourages waste reduction by working through the Governor's Office to solicit from industries a description of their waste reduction initiatives. As a part of this effort, the annual Governor's Innovative Waste Reduction Award for industries was initiated in 1986.
- Conducts research, such as the project recently co-funded by HWRIC to address the feasibility of having a central recovery facility for electroplating wastes in the Chicago area. One option from this study that appeared promising was to develop local treatment facilities that would serve a number of similar generators in an area. Another project is underway to develop in-plant treatment/destruction techniques for certain organic wastes.

Although many Illinois companies are reducing their hazardous waste generation at the source, about half of the generators in the state did not submit a waste minimization statement, which was required on their annual reports to the Illinois Environmental Protection Agency (IEPA). It is obvious that education and technical information dissemination is needed as well as longer-term research in areas such as process modifications, in-plant recycling and treatment, and product substitution.

Very Small Quantity Generator Program

The Very Small Quantity Generator (VSQG) Program is working with those hazardous waste generators who generally produce less than 220 lbs./month, the lower limit for Resource Conservation Recovery Act (RCRA) small quantity generators. This group includes households, the agricultural community, small laboratories (including those in schools), hospitals, and small businesses. To date, much of the waste materials from this group has gone into municipal landfills, public treatment works or septic tanks, storm sewers, or has been poured onto the land. These practices have led to ground-water contamination in some areas.

HWRIC is working to better define this group's hazardous waste problems, provide educational materials to raise awareness of the problems, and assist interested parties in the proper management and disposal of their wastes.

The Status and Adequacy of the Hazardous Waste Data Base

The whole area of hazardous waste management relies on accurate statistics for the kinds and quantities of wastes generated, transported, treated, and disposed of. Unfortunately, the inaccuracy, incompleteness, and inadequacy of the hazardous waste data base are some of the largest stumbling blocks to achieving better hazardous waste management. Part of this is because many of the statistics we have were collected for a regulatory purpose, rather than for research. Our concern is that the statistics we do have are used improperly and that erroneous conclusions are often drawn from the data. HWRIC is attempting to accurately describe the various data files on hazardous waste that are available, determine how they can or cannot be used, and define areas where additional data need to be gathered. This issue is also being addressed on the national level, and HWRIC will coordinate some of its efforts with USEPA.

Hazardous Waste Education and Training Program

Education is an important component of an effective hazardous waste management program, and providing pertinent information on a timely basis is essential. HWRIC is providing hazardous waste information to a wide range of groups and individuals in the state. Seminars, workshops, and presentations for specific groups are another important component of this program. One focus over the last year was to introduce hazardous waste-related curriculum materials to Illinois educators. Beyond these efforts is the need to develop and implement educational outreach projects specifically designed for county and local government officials who often must make important decisions about waste management policy.

C. RESEARCH PROGRAM

Accomplishments in Hazardous Waste Research

HWRIC sponsors research in five substantive areas with the overall goals of assessing the magnitude of the hazardous waste problems in Illinois and finding improved solutions to them. Achieving these goals will enable us to more effectively protect public health and the environment, while providing for jobs and a strong economy. These goals can be accomplished by better understanding how wastes are managed, how released contaminants move through the environment, and what effects they have on the environment. With this understanding we can solve many of our waste problems by more efficient treatment and disposal techniques, waste reduction, and more effective cleanup of

contaminated sites. During the first two years of the Center's operations (FY'85 and FY'86), 25 projects were initiated. Of these, 12 have been completed and 14 reports have been published. Six additional project reports are in various stages of peer review and will be published within the next four months. Seven projects are multiyear efforts and are still in progress.

High-priority research needs are identified through activities of Center staff and through advice from other scientists, university professors, industry representatives, personnel from other government agencies, various public interest groups, and others. This includes guidance from our Research Advisory Committee, Program Advisory Panel and Governing Board. Increased efforts have also been undertaken to coordinate our projects with DENR's Energy and Environmental Affairs' environmental research program, with IEPA, and with the Illinois Pollution Control Board (IPCB). This has occurred through cooperative or jointly funded projects with each of these groups.

Below are some highlights of the HWRIC-sponsored research program. The projects are described in more detail in Section IV, Hazardous Waste Research, in Tables 3, 4 and 5, and in Appendix 1.

Characterization and Assessment

Hazardous wastes are found throughout the environment -- in the air, soil, ground water, and surface waters. Chemicals present in hazardous wastes sometimes are even found in the tissues of living organisms, including people, through various routes of exposure. To fully characterize the occurrence of hazardous wastes and toxic substances throughout the environment would require a major program and long-term effort in a state as large and diverse as Illinois. Therefore, we have focused our studies on areas of known contamination that need to be further defined and on obtaining more complete descriptions of activities that likely have been or are managing hazardous wastes.

To date, 15 research projects that are primarily intended to improve our understanding of the nature and magnitude of the hazardous waste problem in Illinois have been funded. Eleven of those projects have been completed or are in final review; they are listed below by type of objective.

Historical Waste Generation and Disposal Descriptions

- Industrial Wastes in the Calumet Area, 1869-1970: An Historical Geography
- Historical Patterns of Hazardous Waste Management in Winnebago County, Illinois 1870-1980

Data Base Development

- Statewide Hazardous Waste Generation Study
- Initiation of the Hazardous Waste Research and Information Data Base
- Statewide Landfill Inventory
- Special Waste Categorization Study
- Enhancement of the Hazardous Waste-Related Activities Inventory

- Inventory of Hazardous Waste in School Laboratories

Ground Water Assessment

- Evaluation of Current Underground Injection of Industrial Waste in Illinois
- Regional Ground Water Quality Characterization of the Rockford Area, Illinois

Surface Water Assessment

- Potential Hazardous Waste Contamination of Illinois Surface Water Supplies

One of the first projects funded by HWRIC, "Atmospheric Research and Monitoring Study of Hazardous Substances," was to monitor for air toxics at three urban locations and one rural site. The emphasis to date has been on the concentrations and sources of toxic elements (including heavy metals). Sampling during FY'87 and FY'88 will focus on the occurrence of organic contaminants at these sites.

By comparison, a major effort has been undertaken by IEPA over the past three years to monitor public ground water supplies for organic contamination. Some comparative analyses have been conducted by HWRIC-sponsored researchers. In the project "Regional Ground Water Contamination in Illinois," a comparative review and analysis of ground-water quality monitoring data collected in recent years will be completed in the fall of 1987.

The third historical assessment of past hazardous waste activities is being undertaken in the project "Historical Assessment of Hazardous Waste Management in St. Clair and Madison Counties, Illinois 1890-1980," for the East St. Louis area. This complements the other studies conducted in the southeast Chicago and Rockford areas.

The project "Levels of PCBs and Trace Metals in Crab Orchard Lake Sediment, Benthos, Zooplankton and Fish," is assessing the extent of contamination in the Crab Orchard National Wildlife Refuge. This assessment may also provide an indication of the food chain effects of the contaminants. The study should form a basis to evaluate the effectiveness of the site cleanup once that has occurred.

Environmental Processes and Effects

Exposure to hazardous wastes usually results from contaminants entering and being transported through the environment. The rate of movement of contaminants through the environment from various sources and their effects on organisms needs to be determined so that effective actions can be taken to protect the environment and human health.

Two projects have been completed in a major Center-sponsored effort to assess the toxicity and fate of contamination in Waukegan Harbor sediments. These projects are

- Assessment of Ecotoxicological Hazard of Waukegan Harbor Sediments, and
- Phytotoxicity of Waukegan Harbor Sediments

Four active projects involve studies of the environmental processes and hazards to other areas of the state. One major project, "An Assessment of the Environmental Hazard Associated with the Contamination of Lake Calumet, Cook County, Illinois," is addressing

problems in the major industrial area of southeast Chicago. The other three projects are designed to better define the movement of contaminants in ground water. These projects include

- Investigation of the Hydraulic Effects of Deep-Well Injection of Industrial Wastes,
- Geochemical Interactions of Hazardous Wastes with Geological Formations in Deep-Well Systems, and
- Development of Sampling Protocol for Organics in Fine-Grained Material.

Waste Reduction

In response to a solicitation for proposals to perform studies on ways to reduce the generation of hazardous waste, two projects have been funded and several others are being reviewed or negotiated. The two funded projects are

- The Feasibility of Ion-Exchange as an Appropriate Self-Contained Waste Minimization Process for the Electroplating Industry, and
- Facility Waste Reduction Review.

These projects represent the beginning of what is envisioned to be an expanding effort to work with generators and others to minimize hazardous waste problems at the source. Up to five additional projects in this area may be funded in FY'87 and, in FY'88, up to ten may be sponsored.

Treatment, Disposal, and Remediation

More effective and efficient treatment and disposal methods can help reduce the magnitude of Illinois hazardous waste problems for those wastes that are not reduced by other means. The effectiveness of contaminant remediation methods needs to be determined and more effective approaches need to be developed.

Two projects to study alternative approaches to treating hazardous waste have been completed. They are

- Central Recovery Facility for Electroplating Wastes, and
- Spray Dryer Spent Sorbent: Hazardous Waste Fixating and Cementitious Properties.

One active project to develop an innovative treatment technology for destroying hazardous waste is "Solute Effects in Aquifer Cleanup/Hazardous Waste Treatment by Oxy-Radical Processes." This approach, if cost-effective, is also suitable for remediation of contaminated ground waters.

One recently initiated study related to disposal practices and co-funded with the IPCB is intended to result in improved design and siting of hazardous waste landfills. The project is titled "Ground Water Impact Assessment of Contaminant Migration through Typical Surficial Geologic Sequences of Illinois." Along with computerized mathematical modeling techniques, it is using recent scientific advances in our understanding of how

contaminants leach out of landfills and migrate in the subsurface to assess the risks to ground-water supplies of several chemicals in a range of landfill designs and hydrogeologic settings.

One project in the remediation technique development area has been completed ("In Situ Aquifer Reclamation by Chemical Means: A Feasibility Study") and three others started to find more effective ways to clean up contaminated soils and ground water. The three active projects are

- Feasibility of Land Application of Soils Contaminated with Pesticide Waste as a Remediation Practice,
- In Situ Biorclamation of Contaminated Ground Water, and
- Sunlight-Riboflavin Decontamination of Ground Water Containing Chemicals.

Risk Assessment and Policy Analysis

Risk assessment is a relatively new approach that can be used to evaluate the trade-offs between alternatives and to identify activities that pose the greatest threats to human health and the environment. Policy makers can use risk assessments along with other analytical techniques in making environmental policy decisions. Three projects aimed at improved risk assessment have been sponsored by HWRIC. Two studies are in response to a legislative mandate to develop an approach to regulating industrial wastes. These are

- Assigning A Relative Degree of Hazard Ranking to Illinois Waste Streams, and
- Refining the Degree-of-Hazard Ranking Methodology for Illinois Industrial Waste Streams.

The third study "Extrapolation of Toxicological Data to Human Health Effects" was designed with the goal of developing an improved risk assessment method. Two other studies have been sponsored primarily to address policy issues. One mandated study, "Taxing Hazardous Waste," examined various taxing approaches that could be used to discourage the generation of hazardous wastes. The second study, "Development of a Hazardous Waste Management Model for the State of Illinois," is nearing completion. It uses a computerized method that relies on various risk assessments to project the effects of various policy options. The results of this project will be helpful for defining research needs and evaluating alternative hazardous waste management approaches for Illinois.

D. INDUSTRIAL AND TECHNICAL ASSISTANCE

HWRIC's Industrial and Technical Assistance (ITA) Program provides direct technical assistance to Illinois industries and industrial trade associations, communities, and citizens with hazardous waste management problems. The Center emphasizes source reduction, recycling, product substitution, and other methods of reducing the amount of hazardous waste generated within a given plant and also recommends appropriate disposal methods. ITA staff also give regulatory and permitting guidance and make referrals to qualified consultants and service organizations.

In addition, the ITA Program assists, as requested, with hazardous materials problems associated with state and federal employee and community right-to-know, and Occupational Safety and Health Administration (OSHA) regulations.

One priority group for which assistance is being given is small quantity generators (SQGs). ITA staff have produced a "Small Quantity Generators' Compliance Manual" to provide those generators with the information they need to properly manage their wastes. In addition, the ITA Program is sponsoring a number of SQG seminars around the state to explain the regulations that pertain to this group. Speakers at the seminars are from HWRIC, regulatory agencies, disposal firms, trade groups, and others.

In addition to providing assistance to large and small quantity generators, HWRIC also assists the very small quantity generators, who are basically unregulated. Groups assisted have included high school laboratories, hospitals, the agricultural community, municipalities, and individuals with household hazardous waste.

The ITA Program provides help to all of the above groups through direct technical assistance and through providing information from its data base of consultants, laboratories, waste disposal and hauling firms, and equipment vendors.

During the period May 1, 1986 to March 31, 1987, ITA staff have provided technical assistance to 340 groups and individuals. In general, the groups are small or underfinanced and cannot afford to hire a consultant or permanent environmental staff. The types of information given consisted mainly of 1) information on regulatory requirements, 2) distribution through personal or mail contacts of technical information on treatment and disposal, and 3) references to private firms with the needed expertise or products.

Waste reduction is a priority of HWRIC and of the ITA Program. To encourage industries in this area, the Center, under the direction of the ITA staff, has initiated a Recycling, Reduction and Treatment (RRT) Matching Fund Program to encourage testing new technologies and equipment for reduction of hazardous waste generation. These contracts are for approximately \$10,000 each and a total of \$100,000 a year has been committed to this program. Another component of HWRIC's waste reduction program is the development of an Alternative Technologies Data Base. It will consist of new, modified, and innovative technologies for reduction of hazardous wastes, low-waste-generating manufacturing processes, and in-plant treatment.

E. INFORMATION SERVICES

When HWRIC was created it was invested with a mandate to compile, analyze, and disseminate hazardous waste-related information. Fulfilling this mandate is a primary activity of the Center's Information Services Program, which is responsible for the Center's library and clearinghouse. In addition to information collection and dissemination, the Information Services Program is responsible for public affairs and outreach, producing the Center's publications, and providing support to HWRIC's other programs and activities. In this latter role, the Information Services Program helps to integrate the Center's diverse activities.

Collecting and Disseminating Information

HWRIC's library, which is focused almost entirely on topics related to hazardous wastes and toxic substances, now consists of approximately 500 items, including 51 journals and newsletters. Table 6 lists examples from the collection.

The library also provides access to online information systems available through DIALOG and the National Library of Medicine's Medlars system. There are more than 280 data bases available on DIALOG and 20 on Medlars (see Tables 7 and 8).

The Center's Clearinghouse contains multiple copies of materials for general distribution, including HWRIC's publications (research reports, technical publications), fact sheets and brochures.

The Center disseminates information to a broad range of users. Figure 12 illustrates information sources, means of dissemination, user groups, and how the information is used. This year, approximately 1,000 research reports were distributed and Information staff responded to over 100 information requests.

Outreach and Public Affairs

In FY'87 Information staff focused on two major outreach projects: introducing hazardous waste curricula to Illinois teachers and initiating household hazardous waste programs in Illinois. Both of these activities are described in detail in Section III, Major Projects.

Press releases, articles and other publicity about the Center are also an important focus for the Information Program. Fourteen press releases and articles were written in the past year.

Producing the Center's publications is another significant component of Information Services responsibilities. Included are HWRIC's Research Report Series, technical publications, annual reports, program plans, and brochures.

F. HWRIC'S DATA BASE MANAGEMENT SYSTEM

The overall purpose of HWRIC's hazardous waste data base is to help policy makers, companies, researchers and the general public make more informed decisions about hazardous wastes. Hazardous waste management decision making requires accurate and complete information about the volume and types of wastes that are generated, how they are transported, and their final disposition. Twenty-nine data files, related to these needs have been obtained from several sources and made a part of the Center's data base management system. In addition, 16 research projects have been sponsored, each of which, in part, is adding new information to the data files. This includes expanding the inventory of facilities that handle wastes, obtaining access to toxicity data bases to better evaluate the degree-of-hazard of industrial wastes, and evaluation of the adequacy of the hazardous waste data. Data management and research program personnel are also evaluating the completeness and accuracy of the available data.

HWRIC's computing capabilities were expanded last fall by making a direct link with the other Prime computers in the DENR network. This provides plotting and digitizing capabilities and enhanced color graphics. This link also allows direct access and usage of natural resource and other special data files.

During the past year, 16 information requests of HWRIC's data base were received from various levels of government, industry, researchers and the public. This includes a joint effort with the Northeast Illinois Planning Commission to inventory past and present landfills.

G. HAZARDOUS MATERIALS LABORATORY

Early in the development of HWRIC, it was concluded that modern laboratory facilities would be needed to support the Center's programs. In September 1985, \$200,000 was released to begin planning studies for the HML. The engineering/design team consisted of Envirodyne Engineers, Inc. and Holabird and Root of Chicago, and S. M. Altay and Associates of Urbana, Illinois. A planning and preliminary design document was published on June 9, 1986.

Based on this document, \$8.5 million was released for design and construction of the facility. A site was chosen and approved by the University of Illinois. It is just south of the Natural Resources Annex on Hazelwood Drive.

A review meeting with the Capital Development Board (CDB) in mid-February 1987 led to approval of the preliminary design and authorization to begin preparation of bid documents. The cover picture on this Annual Report shows an artist's rendition of the building. The schedule calls for completion of the construction documents and bidding through October 1987, ground breaking in November 1987, and opening of the facility in July 1989.

The HML will house the present HWRIC staff and its five programs, and will include expanded space for the library, clearinghouse, conference rooms, and computer facilities. The laboratory portion of the building contains eight functional areas: receiving and shipping, screening laboratory, biological characterization, soil and sediment preparation, chemical characterization, high hazard laboratory, treatability laboratory, and pilot laboratory. The function of each is briefly described in the report.

The HML is designed as a multi-use facility for research and analytical work on hazardous materials and toxic substances. HWRIC staff will perform some research in support of its programs but generally will work to coordinate and support the research of others utilizing the laboratory facilities.

By having its own Hazardous Materials Laboratory, Illinois will have a facility that can

- give priority to state problems in hazardous materials analysis and research,
- pay particular attention to chain-of-custody and document controls that meet the state's needs,
- provide the appropriate space for state (including university) scientists to conduct a wide range of basic and applied research, and
- provide the flexible space needed for treatability and pilot studies and other larger-scale research projects.

Besides its importance to the state of Illinois, the HML will provide a research facility of both regional and national significance. It will be a state-of-the-art research facility that can draw upon the scientific talents of many local researchers and should be a magnet for outside funding.

I. INTRODUCTION

Governor James R. Thompson and the Illinois legislature created the Hazardous Waste Research and Information Center (HWRIC) in 1984 with a well-defined mission in mind. The new Center would combine research and education; information collection, analysis, and dissemination; and direct technical assistance to industry, agriculture, and communities in a multidisciplinary effort to solve Illinois' hazardous waste problems.

The Center was also invested with specific objectives:

1. reducing the volume of hazardous wastes generated and the threat they pose to human health and the environment,
2. sponsoring research on hazardous waste issues of importance to Illinois,
3. characterizing and assessing the extent of Illinois' hazardous waste problems,
4. assembling, analyzing, and disseminating hazardous waste-related information and making it available to various groups and individuals
5. providing assistance to industry, agriculture, and communities,
6. helping develop and implement a comprehensive hazardous waste management program for Illinois.

HWRIC works to achieve these objectives through its five closely linked programs -- Research, Industrial and Technical Assistance (ITA), Information Services, Data Management, and Laboratory Services. The Data Management Program was established as a separate program in FY'87 to provide better support for the original three programs and the Hazardous Materials Laboratory (HML), which is now in the design phase.

This is the Center's second annual report; it covers the period May 1986 through April 1987. A more detailed discussion of the formation of the Center and its first year's accomplishments can be found in the first Annual Report (HWRIC 86-008); a discussion of the Program Plan for FY'87 (Thomas 1986) is found in HWRIC 87-009.

Many of the accomplishments of the last year have been in the development of specific Center priorities and programs, development of the design for the \$9 million Hazardous Materials Laboratory, and in the establishment of HWRIC as a viable and successful state program. The Center has also established itself on the national level. Working through the National Governors' Association and the United States Environmental Protection Agency (USEPA), HWRIC is coordinating its activities with ongoing federal programs and the programs of other states.

Many of these accomplishments are discussed later in this report under the individual programs. Less visible and more difficult to quantify are the many areas of assistance provided by HWRIC staff to other state agencies, communities, trade associations and individual generators of hazardous waste trying to better manage the waste they produce. It is this assistance to other programs and agencies, dealing with all aspects of the state's hazardous waste problems, that has brought us closer to our goal of being a focal point for hazardous waste management activities in Illinois.

This report describes the function and structure of HWRIC, its various programs and their major accomplishments, and proposed future activities, including development of the HML. Financial and more detailed personnel information are included in a separate document for use by the Board of Natural Resources and Conservation and the HWRIC Program Advisory Panel and Governing Board.

II. HWRIC MANAGEMENT

HWRIC is a part of the Department of Energy and Natural Resources (DENR) and is administered by the Illinois State Water Survey (SWS). The HWRIC management structure is designed to provide for strong management with accountability at all levels.

HWRIC's management structure is shown in Figures 1 and 2. HWRIC is under the direction of the Director of DENR, who interfaces directly with the Chief of the host Division, the SWS. The SWS Chief is Chairman of the Policy and Program Governing Board (called Governing Board) and provides administrative supervision to the Director of the Center. The entire Board works with the Chairman to provide guidance for and approve the policy and programs of the Center. Since the SWS is under the Board of Natural Resources and Conservation (BNRC), HWRIC also reports to and receives direction from the BNRC through the SWS.

ROLES OF DIRECTOR AND PROGRAM COORDINATOR

The Director of HWRIC manages all Center activities and is responsible for the satisfactory performance of all functions. Each May, the Director provides its Policy and Program Governing Board and the BNRC with an annual report that describes programmatic progress, staff, all contracts, and the financial assessment of HWRIC. The Director also prepares an annual operating and financial expenditures plan for submission to the Board by September 1. The Center's Director works closely with an internal research advisory committee composed of senior scientists from DENR Divisions. The Director also receives input from an external program advisory panel comprising representatives of private industry, local and state government, and academia. Memberships of the Board, committees, and panels are given in Appendix I.

HWRIC's three original program elements include the Information Services, Industrial and Technical Assistance (ITA), and Research Programs. Each is under the direction of its program coordinator. The Research Program Coordinator is Assistant Director, and as such assists in the Center's administration. As Research Coordinator he works with Center staff and scientists from each of the Surveys and other DENR Divisions to ensure cooperation and coordination of hazardous waste studies and to plan for future interaction in field studies. He provides planning, guidance, and direction to all of HWRIC's research endeavors, including those conducted by HWRIC staff, the DENR Divisions, and public- and private-sector scientists.

The ITA Coordinator manages HWRIC's industrial and technical assistance activities. This program provides personal and in-plant assistance to Illinois industries of all sizes to help them manage their hazardous waste problems. The Coordinator initiates research proposals that will directly benefit state industries (such as pilot studies for waste reduction) and provides industry with pertinent results from past and ongoing studies. This program also provides technical assistance to others, such as communities and agribusiness, when requested.

The Information Services Coordinator manages the Information Services Program, which serves a dual role for the Center. The program provides data and editorial support for HWRIC's Research and ITA Programs and helps publish the Center's reports and other publications. The outreach activities of the Information Services Program provide the public, governmental agencies, and other researchers with hazardous waste information.

Two additional programs are Laboratory Services, which will be coordinated by a Laboratory Manager; and Data Management, which, at least for the year 1987, will be coordinated by the Research Program Coordinator (see Fig. 1). We expect that this program will have its own coordinator when the Hazardous Materials Lab is completed in the summer of 1989.

ROLES OF GOVERNING AND ADVISORY BODIES

The role performed by HWRIC's Governing Board and two advisory bodies is discussed briefly below. Membership of each is included in Appendix I.

The Governing Board, in concert with HWRIC's Director, provides guidance for and approves the policy, programmatic, and necessary financial direction of HWRIC. The Governing Board is responsive to the Director of DENR. Some of the Governing Board's principal activities related to HWRIC are to 1) set major policies, 2) review and approve annual reports and future plans, 3) approve the budget and funding levels for its programs, and 4) make decisions about the employment of key staff.

The Internal Research Advisory Committee is composed of one member from each Division of DENR. The Committee's primary function is to provide recommendations to HWRIC's Director and staff on the Center's research program, including development of the annual plan and priority areas for research. The Committee provides input into which proposals meet the objectives of the Center's program and should be funded. They provide technical input and guidance on research projects where appropriate, including some participation in project reviews and peer review of reports.

The Program Advisory Panel (Fig. 2) is composed of representatives from the private sector (industry), from academia, and from state government involved in hazardous waste. Panel membership can range from 10 to 12, and members are appointed by the Director of DENR, with each having two-year appointments set on a staggered basis. This panel is convened annually, primarily to review HWRIC's program and to provide guidance as to future needs.

III. MAJOR HWRIC PROJECTS

By the end of its first year, HWRIC had identified four major projects as Center priorities which involved staff from each of HWRIC's program areas. These are described below along with our progress to date. It is likely that each of the projects will be ongoing Center activities for the remainder of this decade.

WASTE REDUCTION PROGRAM

Probably no other aspect of hazardous waste management has gained more national attention over the last year than waste reduction/waste minimization. It has been the major topic of numerous conferences and workshops, and the subject of two major reports to Congress (USEPA 1986; OTA 1986). It has become clear that no industry can escape future liability for its hazardous waste unless it can reduce or eliminate these wastes at the source or treat them adequately to ensure safe long-term disposal.

HWRIC has defined its waste reduction program and the current status of waste reduction in Illinois in a recent publication (Thomas, Kraybill, and Miller 1987). The following material is extracted from this paper and our Program Plan for FY'87 (HWRIC 87-009).

Waste reduction is a national policy in the United States, but it has only very recently gained the support in Congress and in regulatory agencies to make it a true priority. As Joel Hirschhorn of the Congressional Office of Technology Assessment (OTA) stated at a waste reduction conference in June 1986, "For 20 years we've been saying that waste reduction is a top priority, and we haven't been doing anything about it." (Aspen System Corp. 1986) Under the Hazardous and Solid Waste Amendments (HSWA) of 1984, Congress declared that it was ". . . the national policy of the United States that, wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible." USEPA (1986) stated that in the broadest sense, HSWA defines waste minimization as any action to reduce the volume or toxicity of waste. OTA (1986) preferred a more restrictive definition of waste reduction: "in-plant practices that reduce, avoid, or eliminate the generation of hazardous waste so as to reduce risks to health and the environment." Whereas USEPA's waste minimization definition includes source reduction, treatment, and recycling on site and off site, OTA considers off-site recycling and treatment as waste management rather than waste reduction. We believe that OTA's distinction is a valid one; it reflects a prioritization of waste reduction first and waste management second.

Geiser (1983) stated that 20 to 80 percent of the total hazardous waste streams could be reduced by source (waste) reduction. He went on to state, however, that source reduction is still not fully accepted, either in industrial practice or in public policy debates. "This slowness can generally be attributed to three factors: 1) lack of comprehensive planning to encourage source reduction; 2) lack of institutions to assist industries wanting to treat their toxic by-products; and 3) an absence of capital for process and product changes."

HWRIC, having made waste reduction a priority, is helping Illinois industries reduce the amount of hazardous waste they generate. The following activities are a part of the Center's overall waste reduction program.

- Provide technical assistance to industry to help them improve general housekeeping; recycle waste when appropriate, either internally or through material exchanges; propose and provide process modifications to reduce hazardous waste generation; detoxify waste; and substitute nonhazardous for hazardous materials.
- Create a Technology Transfer/Clearinghouse Data Base on alternative technologies. It will be used by various industries and trade groups to reduce hazardous waste generation.
- Administer a matching fund program of up to \$100,000 to support industry in their efforts to modify existing equipment or processes, or to develop new technologies that minimize the generation of hazardous waste.
- Encourage waste reduction by working through the Governor's Office to solicit from industries a description of their waste reduction initiatives. As a part of this effort, the annual Governor's Innovative Waste Reduction Award for industries was initiated in 1986.
- Conduct research, such as the project recently cofounded by HWRIC to assess the feasibility of having a central recovery facility for electroplating wastes in the Chicago area. One option from this study that appeared promising was to develop local treatment facilities that would serve a number of similar generators in an area. Another project is underway to develop in-plant treatment/destruction techniques for certain organic wastes.

Although much waste reduction can be accomplished through better housekeeping, recycling/reuse of materials, product substitution, and process modification, major long-term reductions of waste will often require moderate to major process changes, the use of add-on equipment, and the development of new technology. A long-term research and development program is needed to help industry devise new nonhazardous substitute materials and to evaluate the effectiveness of new equipment or techniques prior to their use. Full implementation of these activities in Illinois will be facilitated by the Center's new HML, which is now in the design phase and is scheduled to be operational in 1989.

Governor's Innovative Waste Reduction Award

One of the more successful components of HWRIC's waste reduction program during the last year was to establish the Governor's Innovative Waste Reduction Award. The awards program accomplished three things: it helped the Center learn more about industries' waste reduction accomplishments in the state; it recognized the efforts industry has already made in reducing its waste; and we hope it provided encouragement to other companies to explore ways of further reducing their waste.

Some 33 applications were received. Other companies called and were interested in applying, but either did not have enough time to apply or could not get approval through their management. It was clear that with a greater lead time, many more companies would have responded.

Company submittals were evaluated for a number of different waste reduction and waste management strategies. These strategies and the number of companies employing them included: source segregation or separation (1), process modification (6), chemical substitution or elimination (8), material recovery and recycling (15), treatment (17),

material exchange (2), replacement of old and/or installation of modern process equipment (4), and management strategies (17). The latter category includes a number of the processes above, but more specifically refers to corporate plans for waste reduction or introduction of nontoxic processes. Many of the applicants had used between two and five of the above strategies. By their estimates, they had reduced their hazardous waste production from between 32 and 100 percent. The primary wastes being treated were solvents and degreasers, and heavy metals.

Although there are those who do not consider waste treatment a waste reduction technique, this was the most common method mentioned. It generally included concentration or detoxification treatment by the generator or a disposer (either at the generator site or the disposal site). Material recovery and recycling was the next most commonly used method for waste reduction. In some cases this was combined with process modification and treatment; for example, where a company used one waste to treat another waste. Process modification (change in equipment or the way chemicals are handled) and chemical substitution or elimination were the next most frequent methods of reducing hazardous waste. In the latter case some companies were able to replace a hazardous material with one that did not produce a hazardous waste.

Awards were presented by the Director of HWRIC and by Lt. Governor George Ryan at DENR's 15th annual conference held in Chicago in early September 1986. The four awards went to

- General Motors Corporation, Central Foundry Division, Danville Plant, for eliminating over 100,000 cubic yards of wastewater treatment sludge and waste corrosive liquid from a hazardous classification,
- Continental Midland Inc., of Park Forest, which has eliminated most of the hazardous residues from its metal cleaning and finishing processes,
- Safety-Kleen Corporation, of Elgin, for their dry cleaner waste recovery service, which recycles dry cleaning chemicals,
- Solvent Systems International, Inc., of West Dundee for development of a system of portable on-site treatment of wastes and recovery of usable materials.

HWRIC will present the second annual Governor's Awards at its "Illinois Hazardous Waste Reduction '87" Conference to be held in Chicago on September 22 and 23, 1987. The conference will also bring together Illinois industry and national experts in waste reduction to look at present progress in this area.

Waste Minimization Statements in Annual Reports

To further determine industries' waste reduction activities in Illinois, we examined a statistically significant number of annual reports and their waste minimization statements, which were submitted to IEPA for calendar year 1985. Some 52.5 percent of the 275 generators' reports examined had a description of their waste minimization efforts. About 41 percent used material recovery and recycling, 15 percent raw material substitution, and 14 percent new process equipment. Additional generator reports are now being analyzed, and the results will be reported at the 42nd Annual Purdue Industrial Waste Conference on May 13, 1987.

VERY SMALL QUANTITY GENERATOR PROGRAM

The USEPA has recently begun regulating Small Quantity Generators (those who produce 220 to 2200 lbs./month of hazardous waste) under the 1984 HSWA. However, those businesses that produce less than 220 lbs./month of hazardous waste are still, for the most part, unregulated. In addition to small businesses, these generators are households, farms, high school and small analytical labs, and other institutions that produce small quantities of hazardous wastes. To date, much of this material has gone into municipal landfills, into public treatment works or septic tanks, into storm sewers, or has been poured onto the land. Because these practices have led to groundwater contamination in some areas, USEPA is considering revisions to the overall regulatory approach for municipal landfills that receive hazardous wastes to make them more capable of handling potentially toxic substances.

HWRIC recognizes the problem posed by these very small quantity generators of hazardous waste, a group which includes all of us. At present the scope and magnitude of the potential problem posed by current disposal methods is relatively unknown. Briefly described below is the Center's program to address this area.

Household Hazardous Waste

Hazardous waste and its associated problems are not the sole domain of large industry, as many of us assume. Each of us uses hazardous materials in our daily lives and generates wastes that are hazardous. We also enjoy the benefits of many material goods whose production generates hazardous wastes as byproducts. Making people aware of these facts is an important goal of HWRIC's focus on household hazardous wastes. Because we all contribute to hazardous waste problems, finding solutions to them will require public involvement.

In FY87, HWRIC launched a program to (1) review household hazardous waste collection programs in other states, (2) initiate program development in Illinois communities, and (3) provide technical support and help coordinate local activities. Our FY87 efforts toward these goals include the following:

1. Review of Other States' Programs.

To review other states' programs, HWRIC staff collected information about household hazardous waste programs from several states. In September 1986, staff members went to Michigan, where they observed three collection events as they were taking place. In November one staff member attended a national conference on hazardous waste programs held in Washington, D.C. We are presently collecting information about household hazardous waste legislation in other states.

There have been more than 530 collection programs in the United States. From them we have learned about planning and conducting successful programs. We have information about program costs, safety and liability issues, and about contracting with hazardous waste disposers. A wealth of data exists describing the types of materials and amounts collected, and average participation rates. Having collected this information, HWRIC is prepared to help communities and others launch pilot programs in Illinois.

2. Informal Workshop: November 10, 1986.

HWRIC sponsored a workshop that brought together interested individuals from health departments, local governments, the League of Women Voters, and the University of Illinois Cooperative Extension. Issues involved with establishing and carrying out programs were discussed, and a network of interested individuals from around the state was established. HWRIC has become an important resource for information about household hazardous wastes and related activities.

3. Draft Plan Submitted to Champaign-Urbana.

HWRIC compiled and submitted to Champaign-Urbana's Intergovernmental Solid Waste Disposal Association a detailed household hazardous waste program plan. HWRIC has worked closely with Association staff to develop this program for Champaign-Urbana. The Association will vote on providing funds for the program in April 1987. If the funds are approved, the collection program will be the first in Illinois.

4. Support to State Legislature.

HWRIC staff are working with the Illinois legislature to draft household hazardous waste legislation. HWRIC has assisted by providing technical and background information, and will be available to testify before legislative committee meetings. We envision legislation that will provide funds for pilot projects and will also protect municipalities from liability during collection programs.

Agricultural Hazardous Waste

The farm community has many of the same waste problems as households. In addition, farms use large quantities of pesticides and herbicides and usually have large amounts of oils and solvents for their heavy equipment. A study of hazardous waste generated by agriculture in four counties in Michigan found that containers for over 145 kinds of potentially hazardous wastes were disposed of by farmers and that the three most abundant containers disposed of were for Atrazine, motor oil and Amiben (Hendri and Yocum, 1984). HWRIC will continue to offer its technical assistance to the University of Illinois Cooperative Extension Service, Illinois Farm Bureau, and the Soil and Water Conservation Districts, and will support hazardous waste collection drives on a community or county basis if the above groups or others wish to sponsor them.

School Laboratory Waste

School laboratories contain many potentially hazardous materials. Old, unused chemicals may pose a particular problem. HWRIC cosponsored a project with the IEPA to inventory hazardous chemicals found in high school laboratories. Some of the chemicals needing disposal included arsenic, benzene (a carcinogen), chloroform, mercury, and picric acid (a potential explosive). The ultimate goal of the project is to conduct a one-time collection of unwanted chemicals that need to be properly disposed of. Beyond this are the educational possibilities for students and teachers alike for training about what materials are hazardous and how they should be properly handled. Efforts in this area are described further in the sections describing the Industrial and Technical Assistance and Information Services Programs.

Hospital Waste

The state has regulations regarding the disposal of many wastes from hospitals. However, some very toxic chemicals are used in hospitals and their disposal is not regulated under the Resource Conservation and Recovery Act (RCRA). HWRIC's ITA staff have been involved in discussions with local hospitals on their waste disposal problems (see Section V, ITA Program for further discussion).

In addition, the whole area of infectious waste is one that needs to be addressed further, particularly due to recent concerns that infectious bacteria may be released in hospital incinerator emissions. The role of HWRIC in this area has yet to be defined.

Small Business Waste

The ITA Program has a continuing responsibility to assist Small Quantity Generators (SQGs) as defined by USEPA (see Section V, ITA Program). In the process of giving seminars, talks, and workshops to various trade groups, we also reach small companies that are not SQGs but still may have wastes that are hazardous. The major problem facing these small companies is proper disposal of their wastes. Often, no transporter will collect their wastes because of the small volume, or if they will, the price is usually prohibitive. In Missouri, it was estimated that small generators sent 2700 metric tons of hazardous waste annually to municipal landfills (EIARA 1985). The estimate of household hazardous waste going to municipal landfills was as much as 23,000 metric tons. The problem is that most landfills are not designed to handle hazardous waste. This is an area needing further definition to determine the extent and magnitude of the problem in Illinois.

THE STATUS AND ADEQUACY OF THE HAZARDOUS WASTE DATA BASE

The whole area of hazardous waste management relies on statistics. What are the kinds and quantities of waste produced? What is the chemical composition of various waste streams, and what are the potential risks posed to the environment and human health by handling and disposal of such wastes? The former director of USEPA's Office of Toxic Substances, Warren R. Muir, recently stated that there is little information available about the specific chemicals in hazardous wastes or the industrial measures available to recycle or avoid production of pollutants (Columbus Dispatch, May 21, 1986).

One difficult problem is just keeping track of the waste, as David Hanson stated in an article for Chemical & Engineering News (January 27, 1986). Quantification has been nearly impossible, and different definitions and calculation methods used by various groups have led to widely disparate numbers.

Ginsburg and Jerabek (1985) reported that, based on the data available for waste handling on a regional basis, large quantities of hazardous waste may be lost from the tracking system. They attributed this to poor record keeping and differences in regulations, definitions, and permit requirements between states.

A report by the Comptroller General of the United States (GAO 1985) stated that a complete inventory of hazardous waste sites does not exist and that many additional waste sites could be added to USEPA's inventory if aggressive and systematic discovery programs were undertaken. There were cases in which states visited by the Government Accounting Office (GAO) identified waste sites that had not been included in USEPA's inventory. This is just one more example of the incomplete (and often inconsistent) data base that we are working with.

A 1986 report by the Illinois Auditor General criticized the IEPA for not properly managing its hazardous waste manifest system. The audit also claimed that the agency was unable to compile a reliable listing of hazardous waste handlers and that the data they had was inaccurate, incomplete, and inadequately verified.

In a more recent study by GAO (1986), it was concluded that USEPA is presently regulating only a small portion of the hazardous wastes generated under the RCRA program. In terms of hazardous wastes that are not yet controlled, GAO (1986) concluded the following:

EPA does not know if it has identified 90 percent of the potentially hazardous wastes or only 10 percent, according to the division director responsible for hazardous waste identification. EPA also does not know whether the wastes not yet listed or subject to a characteristic pose little hazard or are highly toxic. Among the hazardous substances and wastes not brought under RCRA control in EPA's 1980 regulations were dioxins, polychlorinated biphenyls (PCBs), some of the carcinogens listed by the International Agency for Research on Cancer, and many insecticides and herbicides. Also, as noted earlier, since the characteristics identified in the regulations are incomplete, some wastes that could be captured by these characteristics are not being regulated by RCRA.

The report did go on to say, however, that one change USEPA is implementing involves refocusing hazardous waste identification back to emphasis on developing characteristics. A second change, according to the GAO, is the relisting of the already identified listed wastes by developing concentration levels below which the wastes would not be classified as listed hazardous wastes.

The USEPA has recognized that hazardous wastes as defined and included under RCRA have to be revised. The new Toxic Constituent Leaching Procedure (TCLP) test will bring additional waste streams under RCRA regulations, as a result of their leaching characteristics. In addition, the USEPA is examining a new classification system for tracking hazardous waste, which would allow a better determination to be made of the risk posed by various waste streams (Larry Rosengrant, USEPA, personal communication).

HWRIC Director David Thomas provided testimony before the Illinois Pollution Control Board on June 16, 1986, commenting on the Illinois State Chamber of Commerce's proposed amendments to Chapter 7 and 9, R84-17, Docket B. In particular, he disagreed with the Chamber that all non-RCRA wastes by definition pose less risk and do not need the degree of control that RCRA requires. He concluded that many non-RCRA Special Waste streams needed to be carefully regulated for the following reasons:

- 1) The list of wastes regulated by RCRA is expanding.
- 2) It is often not obvious from present data submitted to regulatory agencies if a waste should or should not be classified as a RCRA hazardous waste.
- 3) There are loopholes or exemptions under RCRA that allow some hazardous waste to avoid the RCRA system.
- 4) The HWRIC-sponsored "Special Waste Categorization Study" (Reddy 1985) has shown that a number of so-called nonhazardous special wastes pose a risk to the environment and human health as great as many RCRA wastes.

In addition, the HWRIC-sponsored study "Assigning a Degree of Hazard Ranking to Illinois Waste Streams" by Plewa *et al.* (1986) indicated there are deficiencies in the data needed to define the degree-of-hazard of waste streams. These deficiencies included missing information that was required on the Special Waste Application; data that was necessary for the degree-of-hazard evaluation but not requested on the Special Waste application form; and data on specific components of a waste stream that were necessary for the toxicity hazard category but were not available in the published literature. The authors concluded that "with the very high percentages of applications that rank as 'Unknown' in the overall degree of hazard evaluation it is clear that a severe problem exists with the quantity and quality of information that was available on the Illinois Special waste applications".

HWRIC staff believe that the inaccuracy, incompleteness, and inadequacy of the hazardous waste data base are some of the largest stumbling blocks to achieving better hazardous waste management. Our concern is that the statistics we do have are used improperly and that erroneous conclusions are often drawn from the data. It is important to realize that most data on hazardous waste management are received for regulatory (not research) purposes. These data are usually independently unverified numbers provided by the generators, haulers, treaters, and disposers of hazardous waste. These groups usually do not provide the detail necessary to answer many of the questions being asked by researchers or politicians concerning hazardous waste management. Some of HWRIC's analyses of the state's hazardous waste data base are included later in this report in Section VII, Data Base Management.

HAZARDOUS WASTE EDUCATION AND TRAINING PROGRAM

Education is an important component of an effective hazardous waste management program, and providing pertinent information on a timely basis is essential. HWRIC is providing hazardous waste information to a wide range of groups and individuals in the state. These include hazardous waste generators (large and small quantity generators), communities, government at all levels (the Governor's Office, other state agencies, county and local officials), educators, and school children. New educational components of our programs in FY'87 include the production of informational materials, such as the "Illinois Small Quantity Generators' Manual," HWRIC TN87-002 (Kraybill 1987).

Seminars, workshops, and presentations for specific groups have also been important components of this program. One focus over the last year was to introduce hazardous waste-related curriculum materials to Illinois educators. HWRIC held two workshops for local teachers. The first, on June 17, 1986, provided Champaign-Urbana middle school science teachers with an overview of hazardous waste issues. The second was held on November 3, 1986. Besides providing an overview, curriculum materials developed in California for grades K through 12 were introduced and discussed. In addition, HWRIC gave a presentation at the Urbana Schools Midwinter Conference on February 20, 1986. A presentation on safety in high school chemistry and biology laboratories was given to an in-service training program for science teachers at Bloom Trails High School in Hazel Crest, Illinois, on April 24, 1987.

From our involvement with these teachers we learned that knowledge levels about hazardous wastes are low, even among science teachers, but that interest levels are high. Despite this interest, however, getting teachers to incorporate new subjects into already crowded agendas will not be easy. One solution to this problem is to develop curriculum materials that are complete (including lesson plans). This will reduce the amount of work required by the teachers and may make the curriculum more attractive.

HWRIC plans to continue this effort and will be working with the Illinois League of Women Voters to develop materials. The league will work with educators at the grass-roots level to get materials in schools around the state adopted.

Beyond these efforts is the need to develop and implement educational outreach projects specifically designed for county and local government officials, who often must make important decisions about waste management policy. Education for such policy makers should include basic information about hazardous wastes (what they are, threats they pose); state and federal regulations; waste management technologies and alternatives to land disposal; siting issues; and the importance of initiating programs for managing hazardous wastes from very small quantity generators (see above).

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IV. HAZARDOUS WASTE RESEARCH

NATURE OF THE PROBLEM

HWRIC's research program draws upon scientific and technical resources to address the state's most important hazardous waste problems. The Center supports both basic and applied studies, which in the first few years, focused on establishing a clear definition and understanding of Illinois' hazardous waste problems. The emphasis is now shifting from problem characterization toward better understanding the environmental movement and effects of hazardous wastes. Problem-solving research is also emphasized; it includes improved treatment or detoxification technologies, field remediation technology developments, and waste reduction or minimization studies.

Considerable scientific and technical expertise exists within Illinois to address the state's complex hazardous waste problems. For example, the three Scientific Surveys (Water, Geological, and Natural History) and the State Museum have performed environmental research for over a century and hazardous waste-related research for about 20 years. The needed expertise also exists within the state's public and private universities, industry, consultants, and other research institutions such as Argonne National Laboratory. This expertise has allowed HWRIC to focus quickly on the magnitude of the state's hazardous waste problems and to act as a leader in finding effective solutions. As public awareness has grown regarding the extent of Illinois' hazardous waste problem, it has become clear that the problems need to be better understood and that new, more effective solutions are needed. These solutions range from identifying the waste streams that pose the greatest threat to public health and the environment, to establishing more effective policies to promote innovative engineering technologies that can be used to minimize the volume of waste generated, detoxify those that are generated, treat and securely contain wastes, and clean up areas of contamination.

The Center's research program comprises the following five substantive areas:

1. characterization and assessment of the nature of the state's hazardous waste problems and the magnitude of their threats to the environment and human health,
2. environmental processes and effects studies, which identify the migration characteristics and controlling factors of hazardous waste in the atmosphere, surface waters, soils, and the biota, and also determine the ecological and health effects of contaminants,
3. waste reduction technique development to reduce the volume and threat of hazardous wastes generated through such means as process modification, materials substitution, and reuse/recycling,
4. treatment, disposal, and remediation methods development to reduce the volume and toxicity of the hazardous wastes that are disposed of, to securely contain or destroy any remaining wastes, and to more effectively remediate existing contamination problems, and
5. risk assessment and policy analysis to evaluate the threat hazardous wastes pose to the environment and human health and to assess the advantages and disadvantages of policy options for reducing those threats.

The relationship among these five substantive areas is shown in Fig. 3. As a first step we concluded that waste products from industry need to be characterized and assessed as to their location, volume, and chemical composition. In addition, the state's air, water, and land resources need to be surveyed for areas of contamination that pose a threat to public health and the environment. Ideally, process modifications may be made within an industrial facility to prevent hazardous wastes from being produced or, at least, to reduce the amount produced. The remaining wastes may then be treated and detoxified or, when disposed of, subject to management measures to reduce their potential harm to the environment and human health. The wastes disposed of or released to the environment will eventually go through various transport and transformation processes (migration) that will lead to potential risks to the environment and to people. The types of research conducted in each of these four areas is relevant to policy making and each is, in turn, affected by existing policies. The long-range goal is that the combined results of research studies in these areas will lead to more effective hazardous waste management and reduced risk to the environment and public health through more sound regulatory policies.

PRIORITIZING RESEARCH NEEDS IN THE STATE

HWRIC establishes its yearly research program and priorities by soliciting and evaluating ideas and proposals from scientists and engineers from DENR, other agencies, universities, and the private sector. This is done to ensure that the highest priority needs of the state are being addressed by the most qualified researchers. HWRIC's Research Advisory Committee, Governing Board, and the Program Advisory Panel (described in Section II, HWRIC Management and in Appendix I) are all involved in the process. Rigorous internal and external peer review is used to evaluate proposals, as well as the reports and papers resulting from the research. Our annual schedule for research project development and approval is shown in Table 1. Proposals may be submitted at any time, and some funds are reserved for use throughout the fiscal year to address emerging issues or provide matching support for projects of interest to industry or federal agencies. A schematic flow chart of the proposal review and contracting process is given in Figure 4. While HWRIC's Governing Board is no longer directly involved in the approval of individual projects, the Board does approve overall Center priorities and funding levels.

One important indicator of the coordination role HWRIC has assumed is the numerous meetings in which staff have participated or convened. These meetings usually have been held to identify hazardous waste issues that need study and have involved representatives of government agencies such as IEPA, DENR and Illinois Department of Public Health (IDPH), and university researchers. Industry expertise has been solicited along with the perspective of the consulting community. Other groups approached include various public interest organizations such as the League of Women Voters and Citizens for a Better Environment. These meetings are part of the coordination that is essential for the Center to ensure that Illinois' most significant problems are identified and that the most effective approaches for solving them are pursued.

This year a research seminar series was instituted. Each month the series features a speaker who has some expertise in hazardous waste-related research or policy. The purpose of these seminars is to acquaint all Center staff with current hazardous waste topics. The seminars held so far are listed in Table 2. In addition, numerous research progress management meetings have been held to monitor the direction and quality of the research being conducted under Center sponsorship. One major component of our approach to project management initiated this year is a midyear review. In February, a progress review presentation was given by each investigator. The review was highly effective in bringing

Center research staff up to date with the direction and progress in each project, reviewing plans for completing the current year's project tasks, and planning future work if warranted.

Another way the Center is performing coordination and a leadership role is through cosponsoring an annual research conference pertinent to hazardous waste issues in Illinois. The first was held in May 1986 on the subject of "Ecotoxicology for Illinois: Establishing the Research Agenda." The purpose of this conference was to bring together interested university, state agency, and industrial researchers with the regulatory community to identify priority environmental toxicology issues that need research solutions. The proceedings of that conference are in press. The second HWRIC-sponsored conference is related to industrial waste reduction and will be held on September 22 and 23, 1987. (See Section III, Waste Reduction Program).

PROGRESS IN PREVIOUS YEARS

Most of the research projects conducted during HWRIC's first year of operation were primarily intended to characterize and assess the magnitude of the hazardous waste problem, and some led directly into follow-on projects. A few of the projects also examined the migration of contaminants in the environment. In FY'86 there was a shift in emphasis to more solution-oriented research. To illustrate this progression, we have included below a brief overview of past projects, and an indication of future directions. A more detailed summary of each research project sponsored to date is listed by substantive area in Appendix II.

FY'85 Research Projects

Nine research projects were initiated during HWRIC's first few months of operation (primarily from January to June 1985). They are listed in Table 3. Seven of the projects have been completed and two are ongoing. Several of the projects helped initiate the Center's hazardous waste data base (HWDB), which is more fully described in Section VII, Data Base Management. This data base will continue to be maintained, expanded, and updated by Center staff and by additional sponsored research.

FY'86 Research Projects

Table 4 contains a list of 16 additional research projects initiated during FY'86. While five new projects focused on characterization and assessment of the hazardous waste problem, an equal number of projects addressed environmental processes and effects. This included a major effort to assess the toxicity, ecological effects, and in situ biodegradation of PCBs in Waukegan Harbor. Two of the projects were cosponsored with the USEPA. These projects include a study of the geochemical interactions of hazardous wastes with geological formations in deep-well systems and the investigation of hydraulic effects of deep-well injection of industrial wastes. In all, about \$200,000 of federal funding has been brought into the state.

Four of the projects addressed the development of treatment technologies for hazardous wastes and the effectiveness of remediation methods. One two-year study using toxicological data based on lower organisms was initiated to develop an improved method of predicting risks to human health. Another risk assessment and policy study refined a method to determine the degree-of-hazard of industrial wastes.

Various sites throughout the state have been investigated under HWRIC-sponsored research (Figure 5). In an ongoing project, an inventory of sites that have been used for land disposal of wastes is being compiled for each county of the state. Another project has documented sites of waste generation in a nine-county area in the northeastern portion of the state. Other monitoring studies include regional ground-water studies in Winnebago County, polychlorinated biphenyls (PCBs) in Waukegan Harbor on Lake Michigan, underground injection of wastes in several counties in the east-central part of the state, three air monitoring sites, and several reservoirs that serve as drinking water supplies. Two assessments of waste generation and disposal practices over the past 100 years (one in the Lake Calumet area and the other around Rockford) have also been completed.

Publications resulting from sponsored research and other Center activities during the past year are listed in Section IX, Papers and Reports, which includes eight research reports and 19 papers on a wide range of subjects. These illustrate the diversity of HWRIC staff expertise and interests. Other papers and presentations that have resulted from research sponsored by the Center are listed at the end of this section. To date, seven papers have been published or submitted. In addition, 19 presentations have been made by researchers to various groups, including scientific societies throughout Illinois and the U.S. Combined with the publications and presentations of Center staff, these illustrate HWRIC's commitment to communicate the results of our research to the public, scientists, and to policy makers.

FY'87 RESEARCH PROGRAM

In addition to the seven continuation projects from previous years, 11 new research projects have been sponsored in FY'87. These are shown in Table 5 along with their substantive research areas and anticipated completion dates. New projects were begun in each substantive area with the funding generally distributed as follows: Characterization and Assessment (38%), Environmental Processes and Effects (26%), Waste Reduction (15%), Treatment, Disposal, and Reduction (15%), and Risk Assessment and Policy Analysis (6%).

The geographic distribution of research projects with a field component is illustrated in Figure 6. These range from chemical analysis and assessments of surface waters, sediments, and biota in Waukegan Harbor, Lake Calumet, and Crab Orchard Lake; to air monitoring for toxics in East St. Louis and southeast Chicago; to an assessment of the hydraulics and chemical effects of the underground injection of industrial wastes.

Characterization and Assessment

Projects carried out in the area of characterization and assessment are intended to help determine the magnitude and extent of the hazardous waste problem in Illinois. A number of approaches can be used to do this. For example, in the first year of operation HWRIC began to determine how much and what types of waste are produced and disposed of in the state. While this work continues, current work is focusing on the collection of samples and their analysis for specific geographical areas, media (air, water, etc.) or substances (PCBs, heavy metals, trace elements, and selected organic compounds).

Historic Waste Generation and Disposal

A study being conducted by the Illinois State Museum, "Historical Assessment of Hazardous Waste Management in St. Clair and Madison counties, Illinois: 1890-1980," aims at identifying possible current pollution occurrences in light of past waste generation and disposal practices. Its objectives are as follows:

- reconstruct the past geography of hazardous waste sources and waste disposal sites,
- document waste management practices during the past century,
- compare the historical pattern of waste management sites with recharge areas for public water supplies, and
- indicate areas of hazardous materials accumulation and identify possible zones of water contamination.

Data Base Development

The analysis and upgrading of the HWRIC database is an ongoing project. In the study, "Enhancement of the Database, Year Two", a list of potential hazardous substance handlers compiled from a variety of sources, based on their Standard Industrial Classification, is being made more accurate. Specific tasks include the following:

- addition of period of operation of industries on the original data files by extensive review of public and private records,
- field checking the accuracy of the information on location and type of activity in the enhanced database,
- removal of addresses of locations such as offices in residential areas that are unlikely to handle hazardous materials.

Although the research projects described below fall primarily into the area of characterization and assessment, they also fit into the area of Environmental Processes and Effects (as shown in Tables 3 - 5).

Atmospheric Contamination

Air quality studies are focusing on sampling in two industrialized areas of the state, with control or background levels being established at a rural site. Observation of wind speeds and direction during monitoring provides information on possible sources for air pollutants. The goals of the "Atmospheric Research and Monitoring Study" are to

- determine the levels of 17 toxic trace elements found on airborne particles in southeast Chicago and in the East St. Louis-Granite City area. These have been monitored since fall 1985.
- monitor toxic volatile organic chemicals at the same sampling sites. Sampling began in Fall 1986 and is scheduled to continue until June 1987, although researchers hope to sample for several years.

Results of the study also illustrate general principals of airborne particulate transport and source information for particular contaminants. Preliminary data indicate that steel mills and nonferrous metal smelters (including fugitive emissions from waste piles) appear to be the major sources of airborne toxic trace elements in these areas.

Ground Water

Over the past three fiscal years, various ground water studies have been sponsored by DENR and HWRIC, including sampling of ground water in the city of Rockford, and Winnebago County. This year, research on ground water is being carried out at the former Wilsonville landfill where hazardous waste cleanup activities are concluding. One purpose of "Sampling Protocol Development for Organics in Fine-Grained Materials" is to characterize and assess the seriousness (concentration and type) of contamination at the site. Another purpose is to establish how sampling for volatile organics should be done under the very low hydrologic conductivity conditions found at the site. Therefore, the project also addresses elements of Environmental Processes and Effects as well as Treatment, Disposal and Remediation. The primary objectives of the study are to 1) determine the appropriate time after well pumping or purging to collect a representative ground water sample for volatile organic analysis; and 2) monitor the migration of organic pollutants in the subsurface at the Wilsonville hazardous waste disposal site.

Preliminary findings indicate that most volatile organic compounds were at their lowest concentration in well water before purging and reached their greatest concentration after a few hours of recharge. The contaminants in some of the monitoring wells gradually dissipated after the buried wastes were exhumed.

Surface Waters

In the study "Levels of PCBs and Trace Metals in Crab Orchard Lake Sediment, Benthos, Zooplankton and Fish," researchers are studying the Crab Orchard National Wildlife refuge, which is known to be contaminated with PCBs, metals and other pollutants. The specific objectives are to

- determine PCB and selected trace metal levels in several fish species, benthos, zooplankton and sediments;
- compare PCB and trace metal levels by species (trophic status), age class, and sample location;
- follow the temporal changes that occur in PCB and trace metals in biota should a cleanup operation occur; and
- provide a basis for evaluating the efficacy of cleanup efforts.

Future Direction

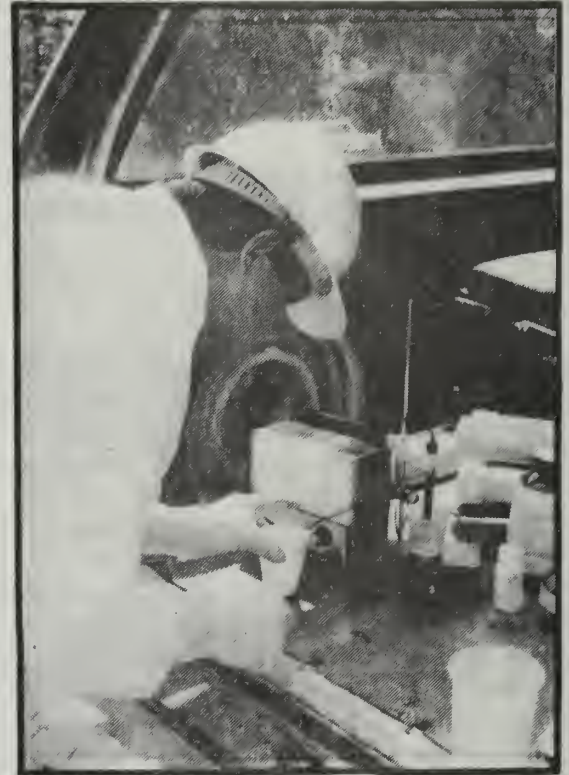
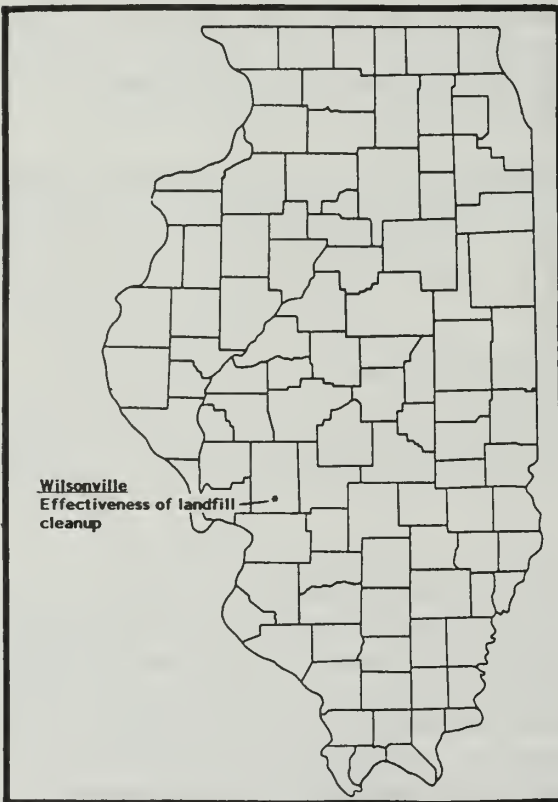
Future directions in Characterization and Assessment tentatively include continuing to build and evaluate the HWDB and updating the statewide landfill inventory begun in FY'85; monitoring air contaminants released from one or more sources, such as lagoons, and stationary or portable incinerators; and follow-up studies in areas where some research has already been conducted. For example, in the Rockford area one study of the historical waste generation and management practices has been completed and a study of the hydrogeology and general quality of the ground water conducted. Follow-on studies could be conducted to determine leachate from known areas of waste disposal and to try to locate the sources of existing contamination.



(a)



(b)



(c)

Researchers from the Illinois State Geological Survey take water samples from an abandoned landfill in Wilsonville, Illinois. This HWRIC-sponsored project is designed to assess water quality sampling methods for volatile contaminants.

- (a) Collection of sample for analysis of volatile organics**
- (b) Phase separation**
- (c) Measurement of pH in groundwater sample**

Illustration 1.

Environmental Processes and Effects

The general purpose of projects conducted in this area is to elucidate the mechanisms whereby pollutants travel in air, soils, and water, and how they affect organisms. As was mentioned above, several projects that fall primarily into the area of Characterization and Assessment also have aspects that pertain to Environmental Processes and Effects. In a similar way, it is usually necessary to assess the extent to which a site or area is contaminated when studying the transport, fate, and effects of contamination.

Surface Waters

In the study "An Assessment of the Environmental Hazard Associated with the Contamination of Lake Calumet, Chicago, Cook County, Illinois," an area that has been industrialized for over 100 years is being investigated. This major study has four main objectives:

- to characterize the concentrations and distributions of contaminants such as heavy metals, polyaromatic hydrocarbons (PAHs), PCBs, and hydrocarbon residues in lake sediments and water;
- to investigate the possible modes of transport of contaminants by ground water, surface runoff and lake currents;
- to quantify the fugacity, or tendency to dissolve and volatilize, of PCB congeners;
- to assess the toxicity of sediment extracts to aquatic life in field and laboratory tests; and,
- to estimate the potential for microbial breakdown of toxic compounds in lake sediments.

Soils

A study titled "Feasibility of Land Application of Soils Contaminated with Pesticide Waste as a Remediation Practice" is being conducted in cooperation with IEPA. In a scenario that undoubtedly recurs around the state, soil near a retail pesticide outlet was contaminated. The primary objective of the study was to determine the suitability of applying pesticide contaminated soil to crop land by showing its effectiveness at controlling weeds; its effects on crop production; the accumulation of pesticides in the crop; and the breakdown of pesticides in the soil. This project was undertaken as an alternative to excavation and landfilling the soil, and so also relates to the Treatment, Disposal and Remediation Technique Development research area and the results are described more fully in that section.

Future Directions

In addition to those projects mentioned under Characterization and Assessment, projects in contaminated areas such as Calumet, Waukegan Harbor, and Rockford are likely to continue. Studies of the effects on biota are expected to be emphasized in the future. Research on ground-water transport and fate may emphasize identification of contaminant sources, and transport and fate modeling. Other research may focus on movement across environmental media such as sediment/water or water/air.

Waste Reduction Technique Development

Reducing the volume and toxicity of hazardous wastes has recently been given higher priority by industry and by federal and state governments. For the long term, it may be the most effective management approach to minimizing the problem. Several studies have shown that in many cases there are a number of steps industry can take with current technologies to significantly reduce the amount of waste generated. The Center's overall program to provide technical assistance to industry and encourage waste reduction is described in Section III, Waste Reduction Program.

The objective of HWRIC's waste reduction research effort is to find ways to overcome technical and institutional barriers to further waste reduction. Some of the barriers identified by the USEPA (1986) and OTA (1986) include the following:

- attitudes toward unfamiliar methods,
- technical and economic limits to recycling/reuse of off-specification materials,
- uncertainty of the effects of process modifications on the quality of final products,
- lack of information on the effectiveness of improved plant operations (better housekeeping, improved materials handling and equipment maintenance, process monitoring/automation, and improved waste tracking or mass balances), and
- problems in measuring waste reduction and in assessing the costs and benefits of waste reduction.

These barriers are, in part, being addressed by the waste reduction research sponsored by HWRIC. During FY'87, HWRIC initiated a matching funding program to encourage projects in waste reduction. Requests for proposals were distributed to industry and trade groups. Approximately 10 percent (\$100,000) of HWRIC's research funds were earmarked to provide assistance to industry, consultants, or university researchers for applied waste reduction studies. Two projects (described below) have been funded to date (Table 5). In addition, one contract will be initiated in May to recycle and reuse some hospital hazardous waste, and several others are in various stages of review.

The goal of the project "The Feasibility of Ion Exchange as an Appropriate Self-Contained Waste Minimization Process for the Electroplating Industry" is to determine whether a particular, innovative ion exchange pretreatment process can effectively minimize hazardous waste generation and ultimate disposal problems for job-shop type metal finishers. The potential for resource recycling from exchange column spent regenerant also will be investigated. The specific objectives of the study are to

- document the procedures and results of the system in operation at a specific plating plant,
- address performance and cost-effectiveness issues needed to substantiate the system's commercial value, and
- investigate appropriate technologies to process and treat the spent regenerant resulting from the regeneration of the pretreatment system final exchange columns.

These goals are being addressed through on-site measurements at the plating shop, laboratory analysis of samples, modeling of certain processes, and an overall effectiveness evaluation for waste reduction and cost savings at this and similar operations.

The second waste reduction project, "Facility Waste Reduction Review," involves an on-site waste minimization profile (or audit) at a steel drum and pail manufacturing plant. Surface conditioning, galvanizing, and painting operations will be reviewed for opportunities for process modification alternatives and the potential for waste exchange. Recommendations for each waste-generating process will include waste reduction actions to be taken and the benefits from expected cost savings.

To find out more about what industry is doing to reduce the generation of hazardous waste, HWRIC is organizing a statewide conference for September 1987. This conference will address the need for improved information on the effectiveness of various alternatives available for waste reduction. Also, through table-top exhibits of process and inplant treatment technologies, information about promising waste reduction technologies will be displayed.

Additional matching funding of \$100,000 will be designated in FY'88 for waste reduction projects. Other research funds will support projects investigating the effectiveness of alternate technologies. One project under consideration is to join several other states in designing and building a bibliographic data base on alternative waste reduction technologies and developing a computerized waste reduction advisory system. Other potential projects to compile relevant and reliable information include preparing waste reduction manuals for specific groups of generators. For example, chemistry laboratories (educational, industrial, and research) have a need for guidance on proper handling and disposal of wastes. Manuals for particular trade groups, such as chemical coaters and foundries, are also needed.

Thus, in the near term, much can be done to promote waste reduction by filling the need for better information. In the long term, new technologies and process modifications need to be developed and demonstrated. HWRIC intends to address the state's needs in waste reduction by this two-pronged approach.

Treatment, Disposal, and Remediation Methods Development

Similar approaches, expertise, and technologies are needed to develop methods to treat and dispose of hazardous wastes, and to clean up contaminated sites. In general, chemical, physical, thermal, and biological processes are used by engineers and scientists to modify the physical form or chemical composition of wastes to render them more stable or less harmful. More effective and less costly methods to destroy hazardous wastes need to be developed. Improved design, siting, and operation of disposal facilities (including landfills, injection wells, and incinerators) would also better protect the environment, but at increased cost in some cases. Also, many of the methods commonly used to clean up contaminated sites were not originally developed for that purpose and have not been fully evaluated. Innovative techniques that appear likely to be more effective for remediating contaminated sites are being developed by researchers and need to be demonstrated.

Treatment Methods Development

One project primarily intended to develop a treatment method for organic pollutants in water, "Solute Effects in Aquifer Cleanup/Hazardous Waste Treatment by Oxy-Radical Processes," was sponsored in FY'87. The purpose of that project is to assess the effects of dissolved substances in aquifers on the efficiency of the UV/ozone treatment

and other processes that use oxy-radicals. The kinetics of these effects will be modeled and used to predict the feasibility of aquifer cleanup and to optimize design and operational parameters. Findings to date indicate that sulfate and phosphate do not adversely affect oxy-radical process efficiencies and that bicarbonate (alkalinity) may not scavenge oxy-radicals as much as previously believed.

Disposal Methods Development

Two projects are being cosponsored with the USEPA to better understand the practice of deep-well injection of industrial (including hazardous) wastes. A third project is examining the siting and design of hazardous waste landfills in Illinois. This project is being co-funded with the Illinois Pollution Control Board (IPCB).

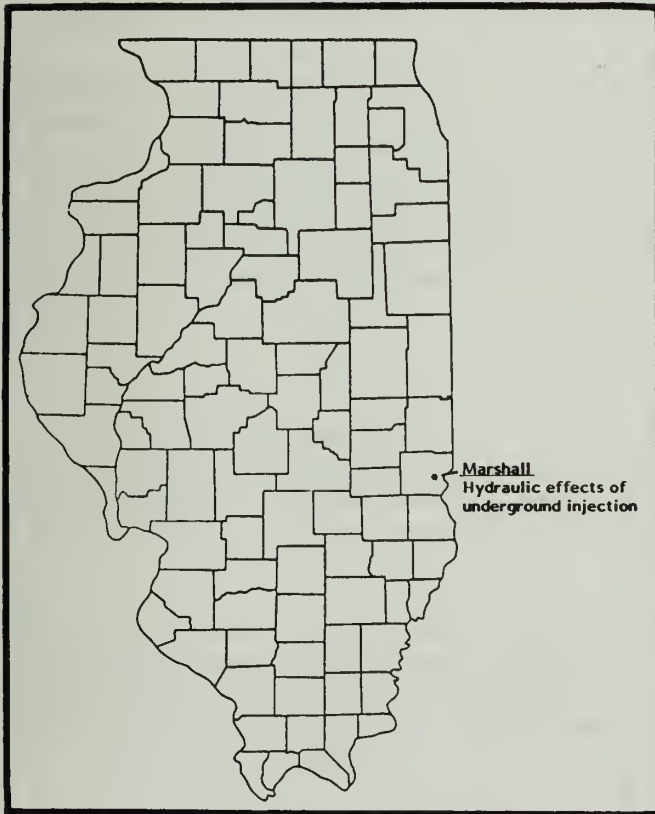
A numerical model is being used in the project, "Investigation of the Hydraulic Effects of Deep-Well Injection of Industrial Wastes," to study the hydraulic effects of this disposal practice on the injection interval and its associated confining units. The injection system to be modeled is being extensively investigated in the field and hydrogeologically characterized. This information is needed to determine the area of influence of an injection well and to predict the long-term fate of injected wastes.

In the project, "Geochemical Interactions of Hazardous Wastes with Geological Formations in Deep-Well Systems," basic geochemical process data on the interactions of hazardous wastes and injection formations are being determined. Studies conducted at room temperature and pressure indicate that the chemical composition of a highly alkaline waste was not significantly changed when it contacted two injection formations and a caprock. An oxidized, acidic liquid waste in contact with an alkaline sandstone became more basic and chemically reduced after 12 days of contact. Minor carbon dioxide evolution did result. Additional tests at elevated temperatures and pressures will also be conducted. The results of this study will help to determine the fate of injected wastes and provide guidance for the laboratory testing of waste formation compatibility.

Contaminant transport in leachate from two levels of design (a standard and more restrictive design) of hazardous waste landfills is being modeled in the project, "Ground Water Impact Assessment of Contaminant Migration Through Typical Surficial Geologic Sequences in Illinois." Fourteen defined geologic surficial deposits that occur in Illinois will be used to estimate the mobility of selected contaminants. This will be based on specific chemical properties and documented hydrogeologic characteristics of the deposits. As a result, sites will be ranked for their suitability for landfill siting and appropriate landfill designs will be indicated. Regulations on landfill design and siting are under development by the IPCB which is co-funding this project. The results of this project will be used to assist in this process.

Remediation Methods Development

Three projects are in progress to develop innovative methods for contamination clean-up. One project being conducted in cooperation with the IEPA involves an innovative remediation approach for pesticide-contaminated soils. There are an estimated 1500 commercial agrochemical retail outlets active in Illinois and many of these sites may have contaminated soils with pesticides due to past waste disposal practices. Conventional cleanup (usually excavation and reburial) is costly and only a temporary solution. An effective and less costly remediation method would result in considerable economic and environmental benefit. The other two projects are intended to test new approaches to ground-water clean up. One involves the use of extraction wells and innovative surface



Researchers conduct a geophysical logging test on an industrial waste injection well in Marshall, Illinois

treatment, while the other project is determining the limits to in situ aerobic biological degradation of organics in ground water.

In the project, "Feasibility of Land Application of Soils Contaminated with Pesticide Waste as a Remediation Practice," the efficacy of applying soil contaminated with pesticide waste to crop land is being determined. It has been found that soil contaminated with an herbicide used in corn fields retains high biological activity (weed control) and moderate toxicity to soy beans. Surprisingly, herbicides in excavated waste piles have not degraded under summer weather conditions, and when applied to crop land, the herbicides associated with contaminated soil seem to degrade more slowly than similar concentrations of freshly applied herbicide. It was also found that a greenhouse bioassay can be successfully used to determine potential crop phytotoxicity from land-applying pesticide wastes. This innovative remediation technique could save small agrochemical businesses the cost of excavating and shipping contaminated soil to a landfill and could lengthen the useful life of existing landfills.

A photosensitizer is being used in the project, "Sunlight Riboflavin Decontamination of Ground Water Containing Chemicals," to destroy insecticide-related chemical contaminant in water. The purpose of the project is to determine if this treatment is effective and sufficiently rapid. To achieve this objective, laboratory kinetic (rate of reaction) experiments will be conducted using environmentally realistic concentrations of ground-water contaminants such as atrazine, aldicarb, 1-naphthol (a break down product of Sevin) and 2, 4, 5-trichlorophenol (a break down product of 2, 4, 5-T). The rate of destruction of the test chemicals by riboflavin is being compared with that of direct photolysis alone, as well as that of samples to which another photosensitizer (methylene blue) is added. Decomposition products will be determined to ensure that more toxic chemicals are not formed in this treatment.

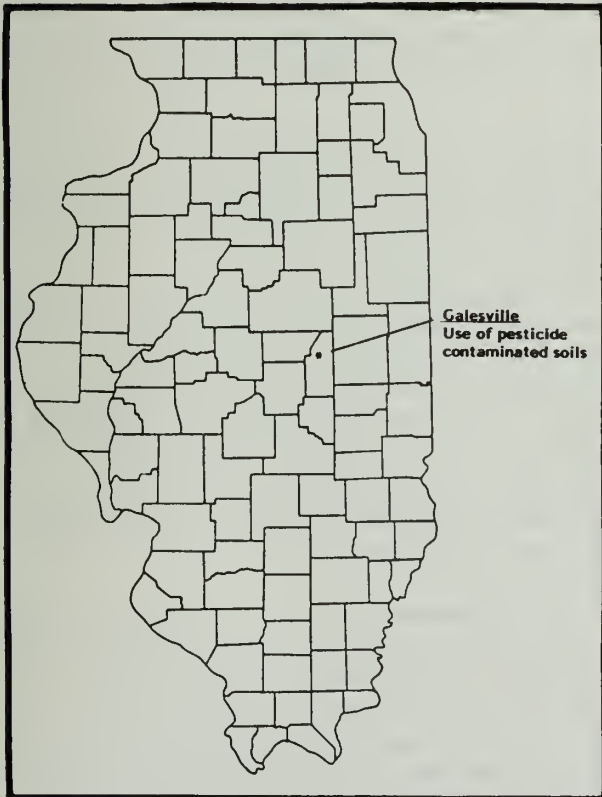
The growth of biofilms in the subsurface for aquifer clean up is being studied in the project, "In Situ Bioreclamation of Contaminated Ground Water." Growth stimulating materials are being injected into laboratory aquifer systems to determine the limits to microbial growth in ground waters and to measure the effects on permeability of the aquifer media. Biofilm kinetics will be combined with flow hydrodynamics in a mathematical computer model so that a rationale or strategy can be developed for effective in situ bioreclamation. Decreased costs and time for cleaning up contaminated aquifers are expected to result.

Future Directions

An increasing proportion of our research funds will be designated for this substantive area in future years. More effective treatment methods will result in greater protection of Illinois' natural resources and, if also more efficient, would result in less cost and liability to the generator. These benefits also will result from the development of improved disposal and remediation methods.

More effective treatment methods are needed for high volume waste streams and the more highly toxic waste streams that are generated in Illinois. This includes many of the organic wastes and metal finishing/electroplating wastes. The indication from preliminary risk assessment results of HWRIC-sponsored modeling studies is that lead- and chromium-containing wastes pose the major portion of the risk from hazardous wastes to the environment and public health.

In the area of determining the effectiveness of current disposal practices, HWRIC is considering research to monitor incinerator stacks for products of incomplete combustion.



HWRIC Director David L. Thomas monitors the progress of a research project in Galesville, Illinois designed to study the application of pesticide-contaminated soil to crop land.

Illustration 3.

With increasing use of solid and hazardous waste incinerators and the popular assumption that incineration is preferable to other forms of disposal, it is important that emissions from hazardous waste incinerators be completely characterized to ensure that toxic compounds are not being released to the environment. The products of incomplete combustion often differ from their parent pollutants, so monitoring devices must be carefully designed and operated.

Also of interest to HWRIC under the category of treatment and remediation, is the field assessment of cleanup effectiveness. Other agencies are responsible for site cleanup, and HWRIC seeks to work with them in a joint effort to test soil and water contaminant levels after excavation and removal of leaking drums and their surrounding soils. The goal is to determine the effectiveness of various cleanup strategies.

Risk Assessment and Policy Analysis

The types of risk assessment and policy analysis studies sponsored draw upon findings in the four other substantive areas of research described previously and illustrated in Figure 3. As chemical constituents in wastes are identified, assessments are needed of their degree-of-hazard or threat to the environment and human health. Current practice relies on the use of toxicological data and understanding environmental transport mechanisms (also discussed under Environmental Processes and Effects) to develop appropriate controls, regulations, and policies.

Risk Assessment

In "A Risk Assessment Model for Direct Acting Genotoxins" scientists are investigating a method that uses tests on lower organisms to predict the effects of chemical compounds on humans. The method involves assigning a "radiation equivalent" to a chemical compound or complex mixture. This approach is desirable since gamma radiation effects on humans are known.

The researchers have established for each of three organisms (corn, a yeast, and a bacteria) the "radiation equivalent" of a particular compound. For example, they have established that for corn, one rad of gamma radiation is equivalent to 2.99×10 moles of ethylmethane-sulfonate (EMS) in terms of mutations caused. Knowing the radiation equivalent of a given compound on one test organism, researchers will then see if they can predict the effects on the other two test organisms. The basis of this extrapolation is DNA content. (Corn has the highest DNA content, followed by yeast and bacteria.) If extrapolations can be made among the three test organisms on this basis, the researchers will have confidence in extrapolating results to humans on the same basis. In this way, effects on humans could be more accurately predicted from simple tests on lower organisms. Such tests could eventually supplement chemical constituent monitoring, or provide the basis for an alternative to it. In addition to selected individual chemicals, complex mixtures that simulate hazardous wastes will be tested.

Two studies conducted during FY'87 were designed to further advance the degree-of-hazard method developed in an earlier study by Reddy (1985). One completed study, "Assigning a Relative Degree of Hazard Ranking to Illinois Waste Streams" (Plewa *et al.*, 1986), assessed a statistically representative sample of waste disposal application files (see applications masters file described in Section VII, Data Base Management) for sufficiency of information to perform a degree-of-hazard evaluation. The degree-of-hazard evaluation of both RCRA (federally defined) hazardous wastes and non-RCRA (other industrial) wastes were compared. In Illinois both of these types of wastes are defined as special wastes and must, as a minimum, be disposed of in a special waste landfill. The findings of

the Plewa *et al.* (1986) study indicate that a degree-of-hazard evaluation can be conducted on Illinois special wastes if sufficient information on waste quantities and chemical composition is available. Further, the study concluded that a system of classifying waste streams by their degree-of-hazard could be economically positive in that those waste streams requiring more costly disposal could be identified and separated from those posing little or no hazard to human health and the environment. The latter could be deregulated and disposed of as a solid waste.

The second study, "Refining the Degree of Hazard Ranking Methodology for Illinois Industrial Waste Streams", improved upon the toxicological basis of the degree-of-hazard methodology. Researchers are developing an interactive computer program that enables the user to perform rapid evaluations of the degree-of-hazard of waste streams. In addition, it provides an easy format to keep the data base current.

Risk assessment research involves the Center in various technology and policy assessment issues. This includes, for example, assessing trade-offs between various disposal options for specific waste streams. Comparative risk assessments to identify the most appropriate disposal options are needed for effective management and regulatory decision making. The first such study, cosponsored by the Center with DENR's Energy and Environmental Affairs group, was an assessment of underground injection of industrial wastes in Illinois. Alternative pretreatment technologies were evaluated by their technical and economic feasibility. However, comparative risks between different disposal options such as deep well injection, land burial, and incineration have not been performed because the data base to assess risks on a comparative basis is just now being developed.

Policy Analysis

Information required for sound policy decisions and waste management includes assessment of the need for additional treatment and disposal capacity, and the effectiveness of the manifest system for tracking the transportation of hazardous wastes (including the import and export of wastes from the state). Computer modeling techniques are being developed to help answer these questions and could be implemented for Illinois using the HWDB along with other information generated by HWRIC-sponsored research projects and by other agencies, including the USEPA.

With the project titled "Development of a Hazardous Waste Management Model for the State of Illinois," researchers are using a computer management/policy options model to accomplish several objectives. First, the regulatory data on hazardous wastes is being used to describe how hazardous wastes are managed in Illinois; this includes types and volumes generated, transport flows within the state, and handling methods used. The computer model uses various data on environmental characteristics, such as depth to ground water and various predictive relationships to assess the relative risks of current hazardous waste management on health, the environment, and on the Illinois economy. A demonstration will also be performed of the model's usefulness to indicate the effects of a range of policy options on the state's hazardous waste management system.

Future Directions in Risk Assessment and Policy Analysis Research

The degree-of-hazard method will continue to be developed in preparation for regulatory hearings to define which waste streams are hazardous. The waste management model will be used to assess trends in waste handling practices and to determine their relative risks to the environment. The predicted effects of various policy options will be assessed with this model to assist policy makers, the Hazardous Waste Advisory Council, and other researchers.

For the long term, it is necessary to develop methods to compare the risks posed by various waste management alternatives. For example, it has not been possible to determine what effects the ban on land disposal of liquid hazardous wastes has on risks to public health and the environment. Comparative risk assessments will allow health and environmental risks to be evaluated along with the associated costs of various options. Scientists and elected officials will be provided with the necessary decision-making information to better site new regional pollution control facilities if needed and to evaluate alternative remedial actions. This information is needed for sound hazardous waste management.

V. INDUSTRIAL AND TECHNICAL ASSISTANCE

HWRIC's Industrial and Technical Assistance (ITA) Program provides direct technical assistance to Illinois industries, communities, and citizens with hazardous waste management problems. The Center emphasizes source reduction, recycling, product substitution, and other methods of reducing the amount of hazardous waste generated within a given plant and also recommends appropriate disposal methods. ITA staff also give regulatory and permitting guidance and make referrals to qualified consultants and service organizations. The ITA Program has instituted an outreach program that provides technical assistance not only to industry but to various groups with hazardous waste management problems, including the educational system, the agricultural community, and industrial trade associations. In addition, the ITA Program assists, as requested, with hazardous materials problems associated with state and federal employee and community right-to-know, and Occupational Safety and Health Administration (OSHA) regulations.

The ITA program staff consists of two engineers with extensive experience with industrial processes and environmental disciplines, and a part-time graduate student.

ASSISTANCE TO SMALL QUANTITY GENERATORS

HWRIC is now assisting Illinois' small quantity generators (SQGs) of hazardous waste. Thousands of firms in Illinois are affected by USEPA's new SQG regulations, which became effective in September 1986. However, IEPA has only about 1000-2000 Illinois SQGs in the regulatory system at present. Since a comprehensive listing of SQGs is not available, reaching this large group through mailings or personal visits is impractical. Thus, HWRIC is continuing to sponsor a series of compliance seminars for this group of businesses.

As with most ITA users, SQGs are generally small firms that lack the staff or time to fully review and comply with the myriad regulations to which they are subject. Thus, HWRIC's SQG seminars focus on new regulations, which are explained and interpreted so that the audience will easily understand them. To fully assist SQGs, HWRIC brings together speakers from six groups:

1. Regulatory Agencies - Personnel from IEPA have been very helpful in explaining regulations and providing an "official" representative to field questions about new and impending regulations.
2. HWRIC - ITA personnel usually speak on waste reduction and disposal procedures. They help bridge the gap between regulators and generators by letting generators know that assistance is available from a nonregulatory agency.
3. Disposal Firms - Speakers who are working in the waste disposal field provide an excellent perspective for generators.
4. Trade Organizations - The Chamber of Commerce and similar organizations often supply speakers for such events.

5. Other State and Federal Agencies - The Illinois Department of Labor, and Federal OSHA, for example, will often provide speakers on workers right-to-know issues.
6. Groups with Other Viewpoints - The insurance industry and small business associations have also provided speakers.

Two seminars were held last year. This year the Center has hosted two, one in Kankakee and the other at LaSalle-Peru. Staff from HWRIC's Information Services Program are assisting with planning, publicizing, and running the seminars. It is expected that up to six will be held next year (see Future Activities below).

In addition, ITA staff have supplied the SQGs with a variety of materials to assist them, including a "Small Quantity Generators' Compliance Manual," written by ITA staff and used to accompany many of the presentations for the SQG seminars. The manual is available as HWRIC publication #TN87-002 (Kraybill 1987).

INFORMATION COLLECTION AND DISSEMINATION

The ITA Program does not have the staff or the mandate to perform as a consulting firm. Thus, ITA personnel have assembled and are constantly updating a data base of consultants, laboratories, waste disposal and hauling firms, and equipment vendors for referral purposes. This data base enables ITA personnel to quickly locate waste management and consulting firms in a user's area and match the consultant's skills with the user's requirements.

Initial contact with the consultants was made through a mass mailing of a questionnaire and through a mailing list supplied by IEPA. The consultants and services data base includes approximately 220 entries, and additional entries are being made continually.

The ITA Program has established a data base of over 1300 industrial trade associations that are based in Illinois or have a substantial membership in Illinois that includes hazardous waste generators.

A questionnaire and form letter were distributed to each trade association. The mailing also included an announcement for the Center's "Illinois Hazardous Waste Reduction '87" conference to be held in Chicago in September 1987 (see Section III, Major Projects). The responses will give us a better idea of the needs these various trade groups have for technical assistance for their members. It will also aid us in planning educational seminars, preparing generic regulatory compliance packages, and providing assistance with regulatory paperwork.

ASSISTANCE TO VERY SMALL QUANTITY GENERATORS

This category of hazardous waste generators has proved most difficult to approach and assist. The category consists of generators of hazardous and toxic waste who produce amounts that are below the present Resource Conservation and Recovery Act (RCRA) generation level (generally 220 lbs./month), and are, therefore, not subject to the provisions of RCRA. The category is exemplified by small manufacturing shops, hospitals, schools, households, etc., all of which generate small quantities of hazardous wastes. In Illinois, it is illegal to landfill hazardous waste without a "proper permit" (35 IL Admin. Code

700.504). There is often confusion about what permits are required for the very small quantity generator, but in general, the requirements are minimal.

Despite the difficulty in reaching this group, the Center's ITA program has made some progress during the past year in approaching these generators and providing solutions to their problems. The ITA Coordinator has been working on an ad hoc multi-agency coordinating committee that includes the Illinois State Board of Education and three other agencies. The committee's goal is to define the magnitude of the hazardous waste disposal problem for chemistry laboratories in the state's secondary schools. During the summer of 1986, the Center cosponsored a study with IEPA to define the problem, and in the summer of 1987, a "milk-run" will be set up across the state to collect and properly dispose of excess hazardous chemicals from the schools' chemistry laboratories. Other work with schools has included consideration of a "cadre training" program for the secondary schools, which will train the people who, in turn, will be providing training to other potential trainers in hazardous materials, right-to-know compliance, and hazardous waste management. Finally, the ITA program has provided on-site service to several community colleges that have requested assistance in dealing with their hazardous waste problems. A private consultant's research proposal to write a guidance manual for school chemistry laboratories is now under consideration.

The agricultural community has not been so easily approached. They fall into the VSQG category (the amounts of waste they generate are relatively small), but some of their waste materials are very toxic. Pesticides, herbicides, and fungicides may end up as wastes, runoff from the land, or enter ground water. The ITA staff has approached the Agricultural Cooperative Extension Service to provide outreach to farmers and applicators. They have proposed for agriculturists updating existing guidance manuals and organizing outreach seminars similar to the SQG series. Presentations have been given to the Farm Bureau and the Associated Illinois Soil and Water Conservation Service, and input was given to a regional meeting in St. Louis, sponsored by a national agricultural pesticide consortium.

The ITA Program has provided direct outreach to hospitals and communities. The Center is considering a proposal under the new Recycling, Reduction, and Treatment (RRT) Matching Funds Program to demonstrate solvent recovery equipment in hospitals and pathology laboratories. Several communities have been assisted with their right-to-know (hazardous materials) programs, and the Center has worked with some community Municipal Sanitary Districts for compliance with their ordinances and pretreatment regulations on industrial discharges of toxic substances. The ITA Program has also worked closely with the University of Illinois Department of Environmental Health and Safety on hazardous waste disposal problems.

Implementing household hazardous waste programs in Illinois and increasing the public's knowledge about toxic substances are also Center goals (see Section III, Major Projects). The ITA Program is working closely with the Information Services Program to disseminate information on household hazardous wastes and to assist communities interested in collection programs. In addition, individuals with larger amounts of hazardous materials (i.e., pesticides and herbicides) often call upon the ITA staff for assistance in the proper handling and disposal of these materials.

RRT MATCHING FUND PROGRAM

The Recycling, Reduction, and Treatment (RRT) Matching Fund Program has been established to encourage testing new technologies and equipment for reduction of hazardous

waste generation. Matching contracts of \$10,000, or possibly greater, are awarded to companies to study practical methods of waste recycling or reduction. The amount is matched by the contractor in some manner, thus doubling the size of the project. The results of each study will be published as an HWRIC report and made available to the public.

The program is intended to encourage practical solutions to waste management problems. And although innovation is encouraged, the program's goal is to provide immediately useable solutions. The original RFP was sent out on October 20, 1986. Three projects have been recommended for approval; two will start in April and one in May 1987.

STATISTICAL SUMMARY

During the period May 1, 1986 to March 31, 1987, ITA staff have provided technical assistance to 340 groups and individuals. These groups consisted mainly of small businesses, state and local government agencies, and citizens' groups. In general, the groups are small or underfinanced and cannot afford to hire consultants or permanent environmental staff.

Assistance was provided to out-of-state groups approximately 70 times. Most of these were companies in neighboring states that either disposed of wastes in Illinois or do business here. Some requests were from other state and federal agencies for information on HWRIC's ITA program.

The types of information given to all who requested assistance consisted mainly of 1) information on regulatory requirements, 2) distribution through personal or mail contacts of technical information on treatment and disposal, and 3) reference to private firms with the needed expertise or products.

Statistical information on the year's activities is shown in Figures 7, 8 and 9. Figure 7 shows ITA activities chronologically over the past year. The peaks in activity often followed presentations or seminars put on by Center staff.

Figure 8 shows the types and frequency of assistance. Actual on-site visits (item 9) have become somewhat unusual because they have proven to be extremely time consuming and are not an efficient use of personnel. Information dissemination through telephone contacts, mailed material, and presentations to groups is more common now than last year.

In an examination of the types of groups assisted, the largest users of our services were other government agencies, SQGs and large generators (Fig. 9). Contacts by other government agencies reflect a need for assistance by small municipalities, state agencies, and by agencies outside the state. Attempts to provide assistance to the agricultural community (items 3 and 4) have not been as successful. The geographical distribution of the assistance shows that activities were concentrated around major industrial areas in Illinois (Figs. 10 and 11).

FUTURE ACTIVITIES

The ITA Program has steadily expanded its scope of activities since its inception. It has been closely monitoring design of the new Hazardous Materials Laboratory (HML) and will continue to do so through the bid and construction periods.

The ITA Coordinator has been advising the Governor's Hazardous Waste Advisory Council. This work has included the coordination and analysis of an industrial survey to determine the magnitude of the most significant hazardous waste problems in Illinois, assistance in formulation of the Council's 1986 report, and technical input at Council meetings.

The ITA staff coordinated the evaluation and presentation of the first Illinois Governor's Innovative Waste Reduction Awards, described in more detail in Section III, Major Projects. The second annual awards will be given at the Center's two-day "Illinois Hazardous Waste Reduction '87" conference in Chicago in September.

A waste management study for the electroplating industry in Chicago, co-funded by the Center and the Energy and Environmental Affairs Division of DENR, was completed in December 1986. Conclusions of that study have focused USEPA interest on the problem and may result in further study.

The ITA staff are presently evaluating the exact status of waste minimization and source reduction in Illinois. This program has resulted in several important papers on the topic. The whole area of waste reduction, which has been a focus from the beginning of the ITA program, is discussed in more detail in Section III, Major Projects.

Another component of the Center's Waste Reduction Program is the development of an Alternative Technologies Data Base. It will consist of new and innovative technologies for reduction of hazardous wastes, low-waste-generating manufacturing processes, and in-plant treatment. It is planned that an existing software package, using data gathered nationally, will be adapted for use on HWRIC's computers. Maintenance of the data base will be an ongoing process. Information from the data base will be available to Illinois industries and citizens.

VI. HWRIC'S INFORMATION SERVICES

In a special message to the Illinois 83rd General Assembly, Governor James R. Thompson (1984) emphasized the central role information must play in the state's efforts to solve hazardous waste problems.

Developing state policy for complex chemical safety issues in an effective manner requires an understanding and knowledge of ever-changing, sophisticated problems and potential solutions. Currently available information does not provide sufficient data for such policy development. Information concerning all aspects of toxic chemicals and hazardous wastes is needed for development of state policy and planning, enforcement, regulations, economic development, and for the education of and assistance to industry, state and local government and the general public.

Fulfilling this mandate to compile, analyze, and disseminate hazardous waste-related information is one of HWRIC's major goals and a primary activity of the Center's Information Services Program, which is responsible for HWRIC's library and clearinghouse. In addition to information collection and dissemination, the Information Services Program is responsible for public affairs and outreach, producing the Center's publications, and providing support to HWRIC's other programs and activities. In this latter role, the Information Services Program helps to integrate the Center's diverse activities.

COLLECTING AND DISSEMINATING INFORMATION

Library

HWRIC's library is focused almost entirely on topics related to hazardous wastes and toxic substances. Information Services staff are responsible for developing and maintaining the library.

The collection now consists of approximately 500 items, including the 51 journals and newsletters that the Center subscribes to. The major sources for material are state and federal governments, with the federal government supplying the most items. New materials are cataloged using either the OCLC system (a commercial online cataloging source) or the University of Illinois' online catalog, LCS.

In FY'87 the Center's periodical collection was entered into the library's data base management system. This system includes bibliographic information and names of staff members to whom publications are routed.

Catalog information is entered into Inmagic, a computer data base management system. With this system the collection can be accessed by author, title, descriptor, title keyword, publisher, and publishing information. The system is also used to print catalog cards for manual searching. The librarian periodically prints a new acquisitions list, which is distributed to HWRIC staff and others.

Because the body of knowledge about hazardous wastes encompasses a wide range of subjects, HWRIC's library contains materials on a variety of hazardous waste-related subjects. Major subjects include general reference, regulatory information, chemicals and

chemistry, federal and state government documents, household hazardous waste, small quantity generators, incinerators, toxicology, and treatment technologies. Examples of specific references are listed in Table 6.

HWRIC's library also provides access to online information systems available through DIALOG and the National Library of Medicine's Medlars system. There are more than 280 data bases available on DIALOG (Table 7) and 20 available through Medlars (Table 8).

Other online sources provide access to more specialized information. The state of Illinois' Legislative Information System provides information on legislation through its Bill Status Inquiry System. Using this system, one can track legislation as well as obtain summaries.

IRIS, the Illinois Researcher Information System, is a computerized data base containing over 3500 entries from organizations that support research and scholarships. The results of a search provide sufficient information for the user to identify sponsors who may be sources for research funds.

In addition to developing and maintaining HWRIC's library, the librarian also provides a number of services to HWRIC staff and others, including:

- identifying sources of materials for purchase or to borrow,
- conducting online searches,
- obtaining materials from the university and other libraries,
- providing a reference service to HWRIC staff and people from outside the Center, and
- compiling specialized bibliographies.

Clearinghouse

HWRIC's clearinghouse contains multiple copies of materials for general distribution. Included are HWRIC's Research Report Series, other HWRIC-produced publications such as the Small Quantity Generators' (SQG) Manual, fact sheets on specific topics, and brochures. Also included are publications from other state agencies and private printers. These publications include a broad range of topics for diverse users, such as technical material (HWRIC's Research Reports), material for generators (SQG Manual), information for nonspecialized users (fact sheets, brochures), and even material for children.

A new system for inventorying and tracking the distribution of clearinghouse materials was instituted by Information Services staff this year. This system will help improve record keeping and indicate user needs and groups served.

Answering Information Requests

Information Services staff respond daily to requests for information about hazardous waste or requests for HWRIC publications. To respond to these requests we use information from HWRIC's library, clearinghouse, and data base, and also draw on the knowledge and expertise of other HWRIC staff members. In FY'87, more than 100 replies to information queries were made by Information Services staff.

Groups Served

HWRIC is fulfilling its mandate to collect and disseminate information to a wide range of user groups in a number of ways. Information sources, means of dissemination, user groups, and how the information is used are illustrated in Figure 12. Specifically, of the approximately 1,000 HWRIC research reports distributed, about 430 went to government, 94 to the business sector, 50 to academia and 24 to public interest groups. Over 400 reports were distributed by individual staff members at seminars and workshops, and by researchers who performed the research. Some of these reports were also sent to individuals not identified with a group. Of the approximately 100 information requests responded to by Informational Service Staff, 28 were to the business sector, 20 to government entities, 16 to public interest groups, 16 to libraries, and 6 to academia. The remainder were requests from individuals.

OUTREACH AND PUBLIC AFFAIRS

Outreach

Providing assistance, technical support, and information to Illinois citizens (public interest groups, teachers, individuals, and communities) is another of HWRIC's mandates and is an important area of focus for the Information Services Program.

In the last year, Information Services staff have focused on two major outreach activities -- introducing hazardous waste curricula to Illinois teachers and initiating household hazardous waste programs in Illinois.

Education/Curriculum Development

In the last year, two workshops were held for local teachers, (Section III, Major Programs). Curriculum materials were introduced and an overview of hazardous waste issues was discussed. Although the knowledge about hazardous waste issues is low, both for students and teachers, the interest in learning more about hazardous wastes is very high. The Information Services Program will continue to work with educators and the Illinois League of Women Voters to provide information for the teachers themselves and to provide curriculum materials that can be used in Illinois classrooms.

Household Hazardous Waste Program Initiation

As part of the Center's "Very Small Quantity Generator" program (see Section III, Major Projects), Information Services staff have worked toward initiating household hazardous waste programs in the state. This has involved the activities described below.

1. Information Services Program staff have gathered information on other states' household hazardous waste programs over the past year. There have been more than 530 such programs in the nation. In addition, HWRIC staff traveled to Michigan in September

1986 where they observed three collection programs. Through personal observation and research, HWRIC has gained sufficient knowledge about household hazardous waste programs to assist Illinois communities wishing to sponsor collection programs.

2. HWRIC sponsored a workshop on November 10, 1986, which brought together interested individuals from health departments, local governments, the League of Women Voters, and the University of Illinois Cooperative Extension. Issues involved with establishing and carrying out collection programs were discussed. A network of interested individuals from around the state was established and HWRIC has become an important resource for information about household hazardous wastes and related activities.

3. The Information Services staff drafted a detailed household hazardous waste program plan for Champaign-Urbana's Intergovernmental Solid Waste Disposal Association. The Association will vote on providing funds for the program in April 1987. If the funds are approved, the collection program will take place in early fall 1987. It will be the first in Illinois.

4. Three talks on household hazardous waste were given. One to the Kankakee Woman's Club on February 18, one at the Urbana Schools Midwinter Conference on February 20, and one at a Sierra Club meeting in Champaign on April 16. In addition, HWRIC staff took part in an hour-long radio interview program concerning household hazardous wastes on WILL radio in Urbana.

5. We have been working with the State Legislature to draft household hazardous waste legislation. HWRIC has assisted by providing technical and background information, and will be available, if necessary, to testify before legislative committee meetings. The proposed legislation has been drafted as HB 1666 and 1667 and appropriates \$500,000 to DENR for grants to units of local government and other costs in connection with the Household Hazardous Waste Collection Grant Program. It also proposes that the Governor designate a "Household Hazardous Wastes Awareness Week" and has wording to protect local governments from liability during collection programs.

Press Releases, Articles, and Center Publicity

Information Services staff are also responsible for disseminating information about HWRIC and its activities to a number of groups, including legislators; businesses, industries and trade groups; public interest groups concerned with hazardous wastes; and state and federal governments.

Since May 1986, 14 press releases and articles have been written and disseminated. As a result, HWRIC's activities have appeared in local and state newspapers, on radio programs and television news, and in trade journals, national journals and magazines dealing with hazardous wastes.

Production of Center Publications

Producing the Center's publications is another Information Services responsibility. Included are HWRIC's Research Report Series, technical publications such as the "Illinois Small Quantity Generators' Manual," annual reports, program plans, brochures, and a Research Report Summary series (the first issue will be printed in June).

Support for Other Programs

Information Services staff provide assistance to other HWRIC programs in several ways. We assist with publicity for all of the Center's activities, including research projects, conferences, seminars, and HWRIC publications. We produce visual aids and graphics (slides, posters, graphs, diagrams), and take photographs. We also provide editing and writing services for other staff.

In addition, we assist the Director and Assistant Director with administrative tasks such as producing annual reports, program plans, and responding to requests from DENR, the Office of the Governor, and other agencies.

VII. HWRIC DATA MANAGEMENT

Effective hazardous waste management requires accurate, up-to-date, and comprehensive information to identify problem areas and provide direction for finding possible solutions. Information is needed on the types and amounts of wastes, where they are produced, and where and how they are disposed of. It is also necessary to know what the most effective alternatives are for safe and legal hazardous waste management under current economic and regulatory constraints. Managers need to be aware of available technologies for handling hazardous wastes and of the emerging technologies that show promise for the future.

Illinois is fortunate to have one of the most comprehensive data bases of any state on industrial waste generation, transportation, and disposal. Since 1979 state regulations have required the IEPA to collect data on industrial and pollution control waste, which includes hazardous as well as nonhazardous materials. The amount of information that must be assimilated to make sound decisions regarding the management of hazardous wastes is enormous. Computers are necessary to assist in storing, retrieving, and analyzing this information and are integral to HWRIC's overall program. This section describes how HWRIC is handling and analyzing the large data base of hazardous waste activities in Illinois.

PURPOSE OF HWRIC'S HAZARDOUS WASTE DATA BASE

The purpose of the data base and management system is to provide support to researchers and information specialists dealing with hazardous waste issues. The data system supports the Center's major programs and researchers under contract to HWRIC. Specific purposes of HWRIC's data base are identified in Table 9. These have been further defined into 12 components as follows:

- Data on Illinois hazardous waste sites, including generators, transporters, and treatment, storage, and disposal facilities.
- Hazardous waste-related bibliographic information,
- An engineering data base on hazardous waste technology,
- Directory of hazardous waste services and expertise,
- Economic, environmental, and demographic information,
- Laboratory sample tracking and custody recording,
- Project and contract management support,
- Communications support with other computer systems,
- Statistical analysis support,
- Geographic analysis and display capability,
- Simulation model development and use,
- Data and system security.

A summary of projects that relate to information gathering, generation, and assimilation is given in Table 10. Each of these projects is more fully described in Section IV, Research. Sixteen of the research projects sponsored by HWRIC or performed by our staff have as their goal implementing and improving the hazardous waste data base management system for Illinois.

HARDWARE AND SOFTWARE

HWRIC's computer hardware includes a Prime 9650 CPU with one megabyte of main memory and 675 megabytes of disk memory. Peripherals include a 1600/3200 bpi tape drive and a high speed line printer. Three WYSE alphanumeric terminals are linked directly to the CPU. Remote access is provided by two 1200/2400 baud modems, which allow personal computer users to access the system by dialing one of two telephone numbers. A Tektronix 4209 high resolution color graphics terminal was ordered in February. Twenty personal computers are in use, either for staff activities or in support of research projects sponsored by the Center. One IBM personal computer is being upgraded with a color graphics package for use by HWRIC staff.

Operating systems for the CPU include Primos, the standard for Prime computers, and Primex, modeled after the Unix operating system. A relational data base management system, Info, is used for storage, retrieval, and analyses of tabular data. Programming languages include Fortran 77 and C. Statistical capability is provided by minitab. PC-based software packages include Wordstar (word processing), Lotus 1-2-3 (spreadsheet), and Rbase 5000 and Info (data base management). Spatial data, such as points, lines, and polygons representing geographic features, are managed with Arc/Info, a geographic information system (GIS).

Figure 13 shows an example application of the GIS system in mapping the location of hazardous waste sites targeted for cleanup in Illinois as of April 1, 1987. The National Priority List (NPL) was established by Comprehensive Environmental Recovery, Compensation, and Liability Act (CERCLA) to provide an orderly means of identifying and prioritizing sites for remediation. Sites are added to or proposed for addition to the NPL based on a numerical hazard ranking system (HRS) designed to evaluate relative risk to health and the environment posed by each site. An HRS value of 28.5 or greater is required for listing on the NPL. The State Remedial Action Priority List (SRAPL) was modeled after the NPL and includes those sites scoring between 10 and 28.5 on the HRS. The physical location of each site shown in Figure 13 was determined from geographic coordinates contained in the CERCLA data base. Once hazardous waste sites are located, it is possible to use the GIS to identify spatial relationships between those sites and other natural resources, infrastructural or cultural features of concern.

A dedicated telephone line, two 9600 baud modems, and Prime network software provide a direct link between HWRIC's computer and those at the Natural History Survey (NHS). As a result, HWRIC personnel can access any one of three Prime computers in the DENR network. This allows use of additional hardware, including a high density (6250 bpi) tape drive, four-color pen plotter, digitizing tablet, several color graphics terminals, and matrix camera equipment. Access to spatial data files at NHS also enhances the Center's capability to address questions about hazardous waste activities and environmental concerns. Of particular interest are the natural resource, land use/land cover, hydrological, infrastructural, and administrative features of the state. For example, given point locations of all hazardous waste sites, those that may pose a threat to surface- or ground-water supplies could be identified based on hydrological and geological properties of the local terrain.

DATA BASE DESIGN AND IMPLEMENTATION

The HWRIC data base is an assembly of regulatory and research data on various hazardous waste issues. The Center is attempting to organize and relate diverse data files into a workable system to allow data analysis and to provide a complete and current picture of hazardous waste-related activities in Illinois. Ultimately the data base will assist Center staff in developing a comprehensive hazardous waste management plan for the state.

Since 1979 all facilities that generate more than 220 pounds per month of industrial wastes in Illinois have been regulated by the IEPA. These wastes are termed "special wastes" (as opposed to municipal wastes) and must be disposed of in a landfill permitted to receive such wastes. Special wastes include waste materials that are defined as hazardous by the USEPA under RCRA, all other (non-RCRA) industrial wastes, and all wastes from pollution control devices such as power plant emission scrubbers. Generators must apply for a disposal permit and must manifest each shipment of special waste that is destined for an off-site facility. They must also provide to IEPA an annual report of their hazardous waste generation. Treatment, storage, and disposal (TSD) facilities also must file reports annually on their waste handling and management activities.

Although state reporting requirements may fulfill legal mandates, they were not intended to provide data to answer research questions. For example, only incomplete information is gathered on waste stream constituents and characteristics, not all generators of wastes are included in the regulatory system (i.e., those that dispose of non-RCRA wastes on site), and there are omissions in the manifest information such as tracking of interstate transport of waste.

The Center initially acquired data from five sources (Table 11). Fourteen separate data files were obtained in late 1984, and an additional 15 files, including updates of original data, have subsequently been acquired. A description of the type of information contained in each file is given in Table 12. General data categories include the location of waste generators and management facilities; waste quantities, types and characteristics of wastes produced; water quality data; and business activity identifiers. Specific contents of each file are listed in Table 13. Note that each category of information is contained in more than one file, e.g., 12 of the 13 files contain some information that identifies generators, TSD facilities, and transporters. However, the information within each category varies by level of detail, completeness, or intended purpose. For example, the waste disposal applications master contain information submitted by facilities that anticipate generating a stated quantity of waste in a given year, whereas the annual hazardous waste reports contain information from facilities that actually generated regulated quantities of waste. A major Center task is to assemble the files into a central data base so that redundancy is eliminated yet subtle differences between data elements are retained. This approach requires that each file contain a common data element to serve as a between-file link, thus forming a single large file from several smaller ones and allowing all data elements to be queried simultaneously. It is then possible to extract information on generator name, waste types, quantities, handling methods, and regulatory information even though the individual data elements reside in separate files.

The original data files were acquired in machine-readable form to facilitate transfer to the HWRIC computer. All data files currently are loaded on the computer and are readable with the Center's data base management system. Initial review and integration of the files was accomplished by Schock *et al.* (1985). Two general types of hazardous waste sites were identified: those known to support current or historic hazardous waste activities, such as RCRA and CERCLA regulated sites, and those that are only potential hazardous waste

sites. For the latter, a screening method was developed to identify potential hazardous material activities based on SIC codes that are known to be associated with such activities. These efforts resulted in a list of 66,584 sites that make up the "Potential Hazardous Substance Activity Site Inventory List." This file was assembled from data elements present in other files and serves as a central location for site-related information. Field checking of potential sites in nine highly industrialized northeastern counties was undertaken to verify the existence of the sites and eliminate those with no hazardous material activities. Also, historical documentation was examined to determine the length of time that hazardous materials were handled at each site (Schock et al. 1986). Ongoing efforts of this type in FY'87 are focusing on the East St. Louis area.

As we use the data base to answer questions regarding hazardous waste sources, characteristics, quantities, destination, etc., several errors and anomalies in the data become apparent. For example, the annual hazardous waste reports for 1982, '83, and '84 were thoroughly checked for missing or incorrect data. The most common error was nonreporting or mis-coding of the USEPA and IEPA identification numbers assigned to hazardous waste generators and TSD facilities. Without these numbers in their correct format, it is not possible to identify the source or destination of the associated waste stream. When reported correctly, these codes provide a means of tracking hazardous wastes out of and into the state, and from county to county within the state. Fortunately, the frequency of these types of errors has been decreasing from 6% of all reported waste streams in 1982, to 5% in 1983, to 1% in 1984.

Another data base anomaly that must be reconciled arises from redundant information. The Center sponsored a study to evaluate the quality of the data regarding consistency and reliability (Raghavan 1985). A comparison was made of waste quantities reported annually by generators, TSD facilities, and transporters. In many cases it was not possible to resolve differences in totals derived from the various sources. For example, to derive an estimate of the total amount of hazardous waste produced in 1984 by a preselected generator and disposed of off site, three approaches are possible: 1) calculate the totals for all wastes reported by the generator in the 1984 annual hazardous waste report, 2) sum all waste quantities reported by TSD facilities as having been received from the generator in question, or 3) calculate total waste quantities that originated from the generator and were transported during the year as reported in the manifest history file for 1984. Although totals derived by the three methods should be identical, often they are not, and it is not obvious which, if any, of the values are correct. Resolving these types of issues is the next phase in preparation of the data base and is crucial to our understanding of the overall hazardous waste picture in Illinois.

ADEQUACY OF THE HAZARDOUS WASTE DATA BASE

As mentioned earlier, the Center's data were acquired from several different sources. This can present a problem when trying to answer a specific question because each file can produce a different answer. The inconsistencies arise from variation in data file content regarding quality, completeness, and method of data collection. Answers provided by a particular data file must therefore be qualified. For example, a recent request was for a list of names of all incinerators in Cook county. Although apparently a simple, straightforward request, the resulting lists differed depending on the data file queried.

To find all incinerators in Cook County, three files that contain disposal information were referenced: selected inventory, waste disposal applications master, and the annual reports (Table 14). The manifest history file also includes information on waste disposal method, but it is often unreported. The annual reports contain information

collected by IEPA once a year, including data on wastes from all facilities that dispose of hazardous waste in quantities greater than 1000 kgs. per month. In 1984 there was one incinerator, SCA Chemical Services, listed in this file for Cook County. This indicates that in Cook County only one incinerator reportedly disposed of more than 1000 kgs of hazardous waste in any one month in 1984. The next files examined were the waste disposal applications master and generic waste stream master. The former is compiled from the IEPA special waste stream application forms which are filled out by TSD facilities who intend to dispose of waste on-site. An authorization number is assigned by IEPA for each listed waste stream and is used on the manifest form to track each shipment of waste. There is an exception to this specific waste stream permit process called a "generic permit." The generic permit covers a general class of waste streams usually intended for a specific form of treatment. Six companies from the waste disposal applications master listed incineration as their disposal method. Three companies had generic permits as incinerators. One company was on both lists. Thus, eight companies were identified as having a permit to use incineration to dispose of special wastes. The selected inventory file contains company names, addresses, and identification as a transporter, generator, or TSD. Companies can be listed as all three if they transport, produce, or treat/store/dispose of special waste in Illinois. Ten general treatment methods are included in the selected inventory file, and five facilities were listed in Cook County as practicing "thermal treatment".

A comparison was made of the lists of incinerators from each of the files. The incinerator from the annual reports for 1984 was found in all the lists. Of the five found in the selected inventory, four were also listed in the waste disposal applications master. One company that was in the applications master file was also found in the selected inventory file, but had no code listed (See Table 14). Therefore, the most complete answer that can be given from HWRIC's data files for incinerators in Cook County is that there is one hazardous waste generator that incinerated more than 1000 kgs per month in 1984, two hazardous waste incinerators that disposed of hospital wastes under a generic permit and disposed of less than 1000 kgs a month in 1984, two companies that incinerated special waste, and one that is most likely a municipal incinerator (which does not handle special waste). Two companies were apparently miscoded in the waste disposal applications master, or they incinerated one waste stream for less than a year before 1983. One company incinerated waste, some of which was hazardous, between 1980 and 1981, but is now listed as a landfill.

This example illustrates the need for an understanding of the limitations of the data files and how important it is to interpret the answers derived from each based on what is known about the files. This is the first step in addressing how much information there is available on the generation, flow, and final disposition of waste streams in Illinois.

The Center is defining the available data files, their limitations, and additional data that are needed to make the data base more accurate and complete. A more complete description of the hazardous waste management system in Illinois is necessary to assist policy makers, companies, and the general public to effectively make informed decisions about hazardous waste. The Special Waste Categorization Study (Reddy 1985) and a more recent study by Plewa *et al* (1986) are another example of our efforts to define the data needs for improved management and regulation of wastes. Waste stream composition and volume data from the waste disposal applications master are being used to determine which waste streams present an environmental risk. This study is defining what information is in this file, the adequacy of the data to determine environmental and human health risks, and the need for additional data to better regulate non-RCRA special wastes.

ASSISTANCE TO OTHERS FOR DATA REQUESTS

During the past year, 16 requests of our data base were made from a variety of users: industry (1), state government (4), county government (1), university researchers (5), other researchers (4), and public interest groups (1).

These queries varied widely in the specific information that was requested. Some examples of requests received include the following: (1) records from our Statewide Landfill Inventory created last year were requested by the IEPA CERCLA program to locate other possible CERCLA sites; (2) information about specific metals included in the special waste applications master; (3) annual summary information for the state on hazardous waste; and (4) all information about hazardous materials for Addison County.

VIII. HAZARDOUS MATERIALS LABORATORY

INTRODUCTION

Early in the development of the Hazardous Waste Research and Information Center, it was concluded that modern laboratory facilities would be needed to support the Center's programs. A draft feasibility study that provided a rationale for the Laboratory as integral to the Center's programs was submitted to DENR on August 20, 1984 (Barcelona 1984). It stated:

Currently there are no facilities available for the sampling, storage, and chemical or physical characterization of hazardous materials and waste streams which contain unknown hazardous components. In order to carry out its mission to provide research, information, and technical and industrial assistance on hazardous waste problems in the State, the Center must provide a facility for the accurate characterization of properties of waste streams and unknown samples. The complete physical and chemical analyses of such samples requires the development of new handling and analytical facilities to insure that exposure hazards to laboratory and related personnel can be minimized. This type of operation must be conducted to adequately control the release of any hazardous materials from the laboratory to the external environment. The proposed facility has been identified as the Hazardous Materials Laboratory (HML).

The report went on to establish the need for a state facility that would incorporate all the safety features necessary for safe handling, analysis, and research on hazardous materials. Its location in Champaign would supplement and complement other laboratory facilities within DENR, the University of Illinois, and the IEPA.

This section briefly summarizes the development of this facility, provides a brief description of the laboratory, and discusses its importance for the support of other HWRIC activities and to the state.

BACKGROUND

On September 10, 1984, the HML Feasibility Study was distributed to the Capital Development Board (CDB), the Bureau of the Budget (BOB), and the HWRIC Research Advisory Committee. Discussions were held in October with CDB and BOB concerning a change of legislation for release of HML planning funds. On February 14, 1985 a briefing on the HML was held with IEPA, CDB, BOB and the governor's staff. During the winter and spring of 1985, communication also occurred between the SWS and UI concerning the HML and the program that would be carried out in the facility.

In May 1985, HWRIC personnel were involved with CDB in selecting a contractor for preliminary planning of the HML. Envirodyne Engineering, Inc. (EEI) was selected as the contractor, and a project initiation meeting was held on July 1. However, it wasn't until about mid-September that \$200,000 was released to begin planning studies.

An "Information Gathering Questionnaire" was sent by EEI to HWRIC on December 9, 1985. It was completed internally by HWRIC staff members and by potential users of the HML within the Scientific Surveys and at the UI. HWRIC returned the completed questionnaire to EEI by the end of December, and all other questionnaires were submitted and discussed at a meeting on January 10, 1986. A synthesis of the questionnaires was

submitted to HWRIC in late January, and a Preliminary Facility Program Document was submitted to HWRIC for discussion on March 6.

During March, Site A-1, located just south of the Natural Resources Annex on Hazelwood Drive, became the primary site for the facility (see Figure 14). This site was chosen after numerous meetings between HWRIC, SWS, and UI. The site was approved by the UI Board of Trustees on November 4, 1986.

Outside input for planning and development of the HML came from a number of sources. HWRIC's Director and Assistant Director visited a number of other hazardous waste labs to learn more about these state-of-the-art facilities. Visits were made to Radian's Lab in Austin, Texas; EPA's hazardous waste facilities in Las Vegas, Denver, and Cincinnati; the United States Fish and Wildlife Services facility in Columbia, MO; and Illinois Institute of Technology Research Institute laboratory in Chicago, Illinois. Also, on November 22, 1985, HWRIC convened an ad-hoc advisory panel to provide input on the HML. This panel consisted of representatives of industry, other agencies, UI, and the Scientific Surveys. The panel was reconvened in late April 1986 to review the draft planning and preliminary design document submitted by EEI. The final document was published on June 9, 1986. (Envirodyne Engineers, Inc. et al. 1986)

A presentation on Envirodyne Engineers' program document for the HML was made to the BOB on July 17, 1986. At the end of the meeting it was agreed that \$8.5 million would be released in FY'87 for design and construction of the facility. An orientation meeting for the design phase of the study was held on October 7, 1986 between the contractors, HWRIC, and CDB. The schedule called for completion of the design development by the end of January 1987, preparation of construction documents and bidding through October 1987, ground breaking in November 1987, and opening of the facility in July 1989.

Preliminary design drawings and a specification document were submitted to CDB and HWRIC on February 2, 1987. A review meeting with CDB on February 13, 1987 led to approval of the preliminary design and authorization to begin preparation of bid documents. A presentation by the design team was made to Chancellor Everhart of the UI and his staff on February 24, 1987. Input from the UI, HWRIC staff, CDB and others continues to be reviewed, and where appropriate, incorporated into the design.

HWRIC also undertook a nationwide search for a Laboratory Manager who would assist in planning the HML, and ultimately direct its daily operations. Three candidates were selected and interviewed in early April. It is hoped that the manager will start work by June first.

FACILITY DESCRIPTION

The Hazardous Materials Laboratory will house the present HWRIC staff and its five programs and will include expanded space for the library, clearinghouse, conference rooms, and computer facilities. These will be located in the administrative offices portion of the building. Eight other functional areas, and their net assignable square footage (NSF), are listed below and will be used for research and analytical chemistry (Fig. 15):

1. Receiving and Shipping - 4000
2. Screening Laboratory - 820
3. Biological Characterization - 468
4. Soil & Sediment Preparation - 454

5. Chemical Characterization - 4239
6. High Hazard Laboratory - 2000
7. Treatability Laboratory - 1470
8. Pilot Laboratory - 2034

Additional descriptions of the facility are included in the DENR design program document for the HML (EEI et al. 1986) and in the design document submitted in early February 1987. The description below is based on the document by EEI (1986).

The Receiving and Shipping area is where all samples and supplies will be received and processed through the facility. General receiving will go to the left of the loading dock and hazardous materials, chemicals, and other supplies to the right. A drum storage area will be adjacent to the loading area.

The Screening Laboratory will be a fully finished laboratory in which one to two people will conduct preliminary analysis to determine the general chemical composition of a sample, its degree of hazard, and appropriate subsequent handling. Higher hazard samples can be passed directly to the high hazard lab for further analysis.

The High Hazard Lab is a highly specialized laboratory suite that includes four individual isolated laboratories connected by an internal corridor to a suite of dressing rooms, showers, and air-lock vestibules. In addition, one treatability lab will be in the high hazard section of the facility to allow room for bench-scale tests on more toxic or hazardous materials.

The Treatability Labs will be multipurpose and will accommodate the set-up and operation of various bench-scale chemical, biological, and physical treatability tests. One treatability lab will be associated with the high hazard section, and the other will be used for lower hazard materials and tests.

The Pilot Lab is a large, flexibly configured industrial space. It will have a 24 foot clear height ceiling, and a second floor balcony to allow work on taller equipment. This lab will have its own loading dock and door to receive large, custom fabricated assemblies. It will house scaled-up studies of treatment technologies or research projects that have shown promise at the bench-scale level. It is planned that at least three such experiments could be done concurrently in this lab.

The Chemical Characterization Lab is a suite of spaces that will accommodate many instruments designed for a broad range of analytical activities. The wet chemistry labs will be preparation and analysis areas for low to medium hazard samples. The instrument labs will house specialized analytical equipment including GCMS/GC instrument lab (650 NSF), ICAP instrument lab (425 NSF) and Fourier - Transform IR instrument lab (425 NSF).

The Soil and Sediment Preparation Lab is located off of the Shipping and Receiving Area and near the Screening Laboratory. It will handle such procedures as grinding soils and sediments, particle sizing, some core-logging, and air drying of samples.

The Biological Laboratory is a finished lab for conducting biological research, primarily toxicity testing. It is envisioned that toxicity testing will be done on relatively small organisms. This area is not designed for toxicity testing on large animals.

LABORATORY OPERATIONS

The HML is designed as a multiuse facility for research and analytical work on hazardous materials and toxic substances. HWRIC is planning to have a laboratory staff of eight to ten people, including a Laboratory Manager, Chief Organic Chemist, Chief Inorganic Chemist, Chemical Engineer, QA/QC & Safety Officer, Sample Custodian, and some technicians. This staff will perform some research directly for the Center and in many cases coordinate and support the research of others utilizing the laboratory facilities. It is planned that the facility will be utilized by researchers from universities, the Scientific Surveys, consulting firms, and industry.

The policies for using the lab and for coordinating its research activities are being developed. In addition, procedures for sample handling and analysis, and safety protocols will be integral to the operation of the laboratory. These will be formalized over the next two years, before the facility becomes operational.

The HML will be an excellent facility in which to conduct training. Certainly all researchers who will use the facility will be required to go through basic training for safety and operational procedures. Access within the facility will be limited by a card access system. The Sample Custodian will maintain up-to-date records of samples and will track samples from receiving through disposal or shipping. The QA/QC & Safety Officer will ensure that all laboratory analytical procedures are accurate and precise and that all safety procedures are being followed.

SUPPORT OF HWRIC ACTIVITIES

The following HWRIC activities will be supported and enhanced through research efforts at the HML.

1. **Field Research Activities** - Additional research is needed into the distribution of regulated and nonregulated toxic compounds in a variety of environmental media. Sampling, analysis, and remedial action methodologies must be developed, field tested, and proven to ensure that acute, as well as chronic exposure estimates are well-founded. Data from these research efforts will help us better understand the significance and consequences of hazardous and toxic materials in air, soil, and water resources.
2. **Laboratory Research Activities** - The HML will provide the modern analytical equipment and safety features for the safe handling and analysis of samples of unknown, moderate, and high hazard. Research involving methods development for new detection procedures, and biological and chemical testing of hazardous substances will all be performed in this facility.
3. **Waste Treatment Research Activities** - Applied chemical and engineering research will be undertaken by HWRIC and/or through industrial supported research on the effectiveness of waste reduction and alternative treatment options for hazardous waste management. Engineering studies will be conducted on waste compatibility, concentration, and pretreatment needs for organic and metal recovery techniques. Methods of upgrading the recycle and resource recovery potential of high volume and hazardous waste streams will be investigated. Similarly, waste preparation techniques for solidification and combined physical, chemical, and biological waste treatment operations must be developed. Chemical research into waste characterization and analysis methodologies is needed where the techniques have

been demonstrated at bench or pilot scale, yet full implementation has been hampered by incomplete evaluation of energy and resource inputs, net efficiencies, or other data development constraints. Sampling methods for waste characterization, homogenization or separation prior to analysis needs to be developed. Generalized protocols for dealing with "unknowns" or waste streams that are variable in composition from a regulatory point of view demand more careful study.

4. Technical Assistance Activities - The Industrial and Technical Assistance Program will work cooperatively with industrial trade groups and specific companies to promote more realistic waste management alternatives. Besides matching grant programs to conduct pilot studies at a particular plant site, other pilot and test programs can best be done in a sophisticated sample handling and analysis facility such as the HML. For example, electroplating and metal finishing operations can be encouraged to implement waste reduction or other disposal alternatives if the efficiency and effectiveness of these concepts can be demonstrated.

IMPORTANCE OF THE HML TO ILLINOIS

When HWRIC was created to focus the state's hazardous waste problem-solving activities in Illinois, it was determined that a Hazardous Materials Laboratory (HML) was essential to accomplish this. The major reasons this state facility is important to assessing and solving hazardous waste problems are as follows:

- A new, modern laboratory facility, equipped with the proper analytical and safety equipment, is needed to analyze highly hazardous and complex waste in the state. Users would include regulatory agencies, industries, and researchers dealing with toxic wastes or unknown wastes that might be highly toxic. The HML will also be an asset to the public, which is concerned about potential contamination in ground water and surface water. In the above cases, the laboratory would be used to handle, prepare, and analyze the waste in a safe manner.
- Second, the laboratory would provide the space and equipment for researchers to perform experiments on toxic chemicals requiring controlled laboratory conditions. Such research might include the mode of transport of chemicals in soil and water, and toxicity tests involving various aquatic and terrestrial organisms.
- Third, industry in the state has a great interest, both because of regulatory constraints and economic considerations, in finding better ways of reducing the amount of waste generated, and of recycling and detoxifying waste. The HML will provide the facilities where treatability and pilot studies can be cooperatively conducted to help solve some of these problems. Financing should come from all possible sources, including regulatory and industrial entities, contractors and equipment vendors, and others. In many cases, smaller companies could work together, with state support, to solve some of their hazardous waste problems by utilizing a facility such as the HML. Financial and technical support could be a cooperative effort between HWRIC and industry or their trade associations.
- Fourth, basic research and educational presentations on the handling, analysis, and treatment of hazardous waste could be effectively and safely accomplished in the HML.

The advantages of this facility to the state over an outside contractual laboratory are many. Outside laboratories often get large batch jobs from USEPA or elsewhere and

have little control over the amount of samples they must handle. Most or all are already backlogged. What this means to the state is possibly poor quality control and long time delays in getting samples analyzed. No single contractual laboratory has the full range of capabilities planned for the HML, including field investigation, sample receiving and analysis, and treatment process development and demonstration. In addition, health and safety requirements in laboratories are becoming more stringent. Thus, the HML will be one of the few facilities in the state or Midwest with modern analytical equipment housed in a laboratory designed to meet the highest standards of health and safety.

By having its own Hazardous Materials Laboratory, the state will have a facility that can

- give priority to state problems in hazardous materials analysis and research;
- pay particular attention to chain-of-custody and document controls that meet the state's needs;
- provide the appropriate space for state (including university) scientists to conduct a wide range of basic and applied research; and
- provide the flexible space needed for treatability and pilot studies and other larger-scale research projects.

REGIONAL AND NATIONAL SIGNIFICANCE

Besides its importance to the state of Illinois, the HML will provide a research facility of both regional and national significance. Located on the south campus of the UI, this facility will be readily accessible to scientists doing research on hazardous materials, both at the university and at the Scientific Surveys. It will be close to industries in Chicago, East St. Louis, Indianapolis, and elsewhere that presently have an interest in hazardous waste research.

By the time the HML opens in July 1989, the Hazardous Waste Research and Information Center (HWRIC) will have been sponsoring research projects for about 5 years. State research funds totaling more than \$5 million will have been obligated. HWRIC has defined the state's research needs in hazardous wastes and will have a program developed to maximize use of the HML when sophisticated laboratory facilities are needed for research. Because Illinois is one of the largest generators of hazardous waste in the nation, solutions developed here will have significance throughout the country. HWRIC is working with USEPA and other states, through the National Governors' Association, to ensure that Illinois' research program is also addressing problems of national interest. We are working to ensure that we do not duplicate efforts being done elsewhere and that projects of mutual interest can be conducted cooperatively.

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Thompson, James R. 1984. "Chemical Safety Research Initiative." Special message to the Honorable Members of the 83rd General Assembly.

U.S. Environmental Protection Agency. 1986. Minimization of Hazardous Waste, Executive Summary and Fact Sheet. Report to Congress. Washington, DC: The Agency.

U.S. General Accounting Office. 1986. EPA Has Made Limited Progress in Determining the Waste to be Regulated. GAO/RCED 87-27. Report to the Chairman, Subcommittee on Commerce, Transportation and Tourism, Committee on Energy and Commerce, House of Representatives. Washington, DC: The Office.

U.S. General Accounting Office. 1985. EPA's Inventory of Potential Hazardous Waste Sites is Incomplete. Report by the Comptroller General of the United States. GAO/RCED-85-75. Washington, DC: The Office.

"Waste Reduction Conference Focuses on Financial, Regulatory Incentives." Hazardous Waste Report. Rockville, NY: Aspen System Corporation. 1986:8(9).

TABLES

TABLE 1. SCHEDULE FOR PROPOSAL/RESEARCH DEVELOPMENT - FY'88

<u>Date</u>	<u>Activity</u>
October - December, 1986	Development of research projects for solicitation. Input from Research Advisory Committee, PIs, other contacts and preproposals.
January 12, 1987	Publication of RFPs and distribution of general solicitation.
February 23, 1987	Full proposals due.
February 23-27, 1987	Internal organization and RAC comment.
March 2-31, 1987	External review period (30 days).
April 20, 1987	Overview of review with RAC.
April 27 - May 22, 1987	Governing Board review.
June 1, 1987	Contracts prepared and submitted
July 1, 1987	Contracts begin.

Table 2. RESEARCH SEMINARS HELD DURING FY'87

- Sept. 22, 1986 - Sue Schock, SWS "HWRIC Date Base Enhancement: What's It All About?"
- Oct. 17, 1986 - Howard Learner, EPI-"Waste Minimization in Europe."
- Oct. 22, 1986 - Adrian Visocky, SGS "An overview of Underground Injection of Industrial Wastes."
- Nov. 7, 1986 - Richard Larson, IES "Photo destruction of Xenobiotics: Hazardous Waste Applications."
- Jan. 16, 1987 - Michael Barcelona, SWS - "Overview of Groundwater Sampling Materials Issues."
- Feb. 27, 1987 - Rex Hess, Veterinary Biosciences, University of Illinois "Acute Exposure and Temporal Analysis in Male Reproductive Toxicology."
- Mar. 27, 1987 - Beverly Herzog, SGS - "Wilsonville Landfill: Historical Perspectives and Current Research."
- April 24, 1987 - Bruno Risatti, SGS "PCB Concentration and Microbial Activity in Anaerobic Sediments at Waukegan Harbor."

TABLE 3. SUMMARY OF PROJECTS INITIATED DURING FY '85

Project Title	Substantive Area				Status/ Completion Date	HWRIC Report Number
	C&A	EP&E	WR	TD&R RA&PA		
Statewide Hazardous Waste Generation Study	(x)				Completed	RR002
Initiation of the Hazardous Waste Research and Information Database	(x)				Completed	RR006
Statewide Landfill Inventory	(x)				Completed	RR010
Special Waste Categorization Study	(x)			x	Completed	RR005
Taxing Hazardous Waste				(x)	Completed	RR004
Industrial Wastes in the Calumet Area, 1869-1970: An Historical Geography	(x)				Completed	RR001
Evaluation of Current Underground Injection of Industrial Waste in Illinois	(x)				Completed [Final Draft]	RR008
Atmospheric Research and Monitoring Study of Hazardous Substances	(x)			x	June 1988 [Annual]	RR007 RR014
Regional Ground Water Contamination in Illinois	(x)			x	Aug. 1987	

a Key to symbols under substantive area:

- C & A = Characterization and Assessment
- EP & E = Environmental Processes and Effects
- WR = Waste Reduction Techniques
- TD & R = Treatment, Disposal and Remediation Methods
- RA & PA = Risk Assessment and Policy Analysis

(X) = Primary Substantive Research Area
 (x) = Secondary Substantive Research Area

TABLE 4. SUMMARY OF PROJECTS INITIATED DURING FY'86

Project Title	Substantive Area (a)				Status/ Completion Date	HWRIC Report Number
	C&A	EP&E	WR	TD&R RA&PA		
Historical Patterns of Hazardous Waste Management in Winnebago County, Illinois 1870-1980	(x)				Completed	RR011
Regional Ground Water Quality Characterization of the Rockford Area, Illinois	(x)	x			Under Review	
Potential Hazardous Waste Contamination of Illinois Surface Water Supplies	(x)				Under Review	
Assessment of Ecotoxicological Hazard of Waukegan Harbor Sediments		(x)		x	Under Review	
Central Recovery Facility for Electroplating Wastes			(x)		Completed	*
<u>In Situ</u> Aquifer Reclamation by Chemical Means: A Feasibility Study			(x)		Under Review	
Spray Dryer Spent Sorbent: Hazardous Wastes Fixating and Cementitious Properties			(x)		Under Review	
Enhancement of the Hazardous Waste-Related Activities Inventory	(x)				Completed	RR012
Assigning a Relative Degree of Hazard Ranking to Illinois Waste Streams	x			(x)	Completed	RR013
Geochemical Interactions of Hazardous Wastes w/Geological Formations in Deep-Well Systems		(x)			Aug. 1987	

* ILENR/RE-WR-86/12

TABLE 4. Continued

Project Title	Substantive Area (a)				Status/ Completion Date	HWRIC Report Number
	C&A	EP&E	WR	TD&R RA&PA		
Investigation of the Hydraulic Effects of Deep-Well Injection of Industrial Wastes		(x)		x	Oct. 1987	
Phytotoxicity of Waukegan Harbor Sediments		(x)			Under Review ¹	
Development of Sampling Protocol for Organics in Fine Grained Material		(x)		x	Aug. 1987	
Extrapolation of Toxicological Data to Human Health Effects		x		(x)	March 1988	
Inventory of Hazardous Waste in School Laboratories	(x)				Completed ²	
Feasibility of Land Application of Soils Contaminated with Pesticide Waste as a Remediation Practice				(x)	May 1987	

^a Key to symbols under substantive area:

- C & A = Characterization and Assessment
- EP & E = Environmental Processes and Effects
- WR = Waste Reduction Techniques
- TD & R = Treatment, Disposal and Remediation Methods
- RA & PA = Risk Assessment and Policy Analysis

- (x) = Primary Substantive Research Area
- x = Secondary Substantive Research Area

¹ will be incorporated into "Assessment of Ecotoxicological Hazard of Waukegan Harbor Sediments"

TABLE 5. NEW PROJECTS INITIATED DURING FY'87

Project Title	Substantive Area (a)				Status/ Completion Date
	C&A	EP&E	WR	TD&R RA&PA	
Levels of PCBs and Trace Metals in Crab Orchard Lake Sediment, Benthos, Zooplankton and Fish	(x)	x			June 1987
Historical Assessment of Hazardous Waste Management in St. Clair and Madison Counties, IL 1890-1980	(x)				June 1987
An Assessment of the Environmental Hazard Associated with the Contamination of Lake Calumet, Cook County, IL	x	(x)			June 1987
Solute Effects in Aquifer Cleanup/ Hazardous Waste Treatment by Oxy-Radical Processes			(x)		June 1987
In-Situ Bioreclamation of Contaminated Groundwater			(x)		June 1987
Development of a Hazardous Waste Management Model for the State of Illinois				(x)	Aug. 1987
Refining the Degree of Hazard Ranking Methodology for Illinois Industrial Waste Streams	x			(x)	Aug. 1987
Sunlight-Riboflavin Decontamination of Groundwater Containing Chemicals			(x)		March 1989

TABLE 5. Continued

Project Title	Substantive Area (a)				Status/ Completion Date
	C&A	EP&E	WR	TD&R RA&PA	
Ground Water Impact Assessment of Contaminant Migration through Typical Surficial Geologic Sequences of Illinois The Feasibility of Ion-Exchange as an Appropriate Self-Contained Waste Minimization Process for the Electroplating Industry Facility Waste Reduction Review		x		(x)	March, 1988
			(x)		Sept., 1987
			(x)		Nov., 1987

^a Key to symbols under substantive area:

- C & A = Characterization and Assessment
- EP & E = Environmental Processes and Effects
- WR = Waste Reduction Techniques
- TD & R = Treatment, Disposal and Remediation Methods
- RA & PA = Risk Assessment and Policy Analysis

- (x) = Primary Substantive Research Area
- x = Secondary Substantive Research Area

TABLE 6. SELECTED HWRIC LIBRARY HOLDINGS

GENERAL REFERENCE

CRC Handbook of Chemistry and Physics. Boca Raton, FL: CRC Press, Inc., 1986.

Illinois Industrial Directory. Twinsburg, OH: Harris Publishing, Co., 1986.

Illinois Farm Chemicals Handbook. Willoughby, OH: Meister Publishing Co., 1986.

The United States Government Manual. National Archives and Records Administration, 1986.

REGULATORY INFORMATION

Code of Federal Regulations. Washington, DC: National Archives and Records Administration, 1986.

Illinois Administrative Code. Springfield, IL: Office of the Secretary of State, 1985.

Environment Reporter. Washington, DC: The Bureau of National Affairs, Inc. (Looseleaf service, updated weekly.)

CHEMICALS AND CHEMISTRY

Environmental Health Chemistry: The Chemistry of Environmental Agents as Potential Human Hazards. Ann Arbor, MI: Ann Arbor Science Publishers, 1981.

Cutting Chemical Wastes: What 29 organic chemical plants are doing to reduce hazardous wastes. New York: INFORM, 1985.

CHRIS: Hazardous Chemical Data. Washington: U.S. Coast Guard, 1984.

FEDERAL AND STATE GOVERNMENT DOCUMENTS

From IEPA, USEPA, NTIS, USGAO, and NTIS.

HOUSEHOLD HAZARDOUS WASTE

Household Hazardous Waste: Solving the Disposal Dilemma. Sacramento, CA: Golden Empire Health Planning Center, 1984.

A Survey of Household Hazardous Wastes and Related Collection Programs. Washington, DC: US EPA, 1986.

SMALL QUANTITY GENERATORS

National Small Quantity Hazardous Waste Generator Survey. Springfield, VA: NTIS, 1985.

Understanding the Small Quantity Generator Hazardous Waste Rules. A Handbook for Small Business. Washington, DC: USEPA, 1986.

INCINERATION

Assessment of Incineration as a Treatment for Liquid Organic Hazardous Wastes. Washington, DC: USEPA, 1985.

Costs for Hazardous Waste Incineration: Capital, Operation and Maintenance. Park Ridge, NJ: Noyes Pubs., 1985.

TOXICOLOGY

Aquatic toxicology. New York: John Wiley & Sons, 1983.

Comparative Toxicology of Laboratory Organisms for Assessing Hazardous Sites. Washington: US EPA, 1985.

TREATMENT TECHNOLOGIES

Centralized Waste Treatment of Industrial Wastewater. Park Ridge, NJ: Noyes Publishers, 1985.

Reference Guide for Industrial Wastewater. Springfield, VA: Corps of Engineers, 1985.

TABLE 7. SELECTED DATA BASES AVAILABLE THROUGH DIALOG

Agrochemicals Handbook. A new data base that provides data on 500 of the world's most important agrochemicals. Information is drawn primarily from literature of pesticide manufacturers.

Biosis Previews. Comprehensive coverage of worldwide research in the life sciences. Presents bibliographic citations from over 9,000 primary journals and monographs.

CA Search. Broad coverage of the literature of chemistry and its application as it appears in the printed Chemical Abstracts, but with the improved precision and speed of computer searching.

Chemical Regulations and Guidelines System. An index to U.S. federal regulatory material relating to the control of chemical substances covering federal statutes, promulgated regulations, and available federal guidelines, standards, and support documents.

Compendex. Online version of Engineering Index. Provides abstracted information from the world's significant engineering and technological literature.

Computer Database. Contains abstracts from many sources of information including journals, proceedings, and business books covering almost every aspect of computers, telecommunications, and electronics.

Enviroline. Comprehensive, interdisciplinary indexing and abstracting of the world's environmental information provided by 5,000 international primary and secondary publications reporting on all aspects of the environment.

Inspec. The largest English-language data base in the fields of physics, electrotechnology, computers, and information technology.

Pollution Abstracts. A leading resource for references to environmentally related literature on pollution, its sources, and control.

TABLE 8. SELECTED DATA BASE AVAILABLE THROUGH MEDLARS

Chemline. A dictionary of over 650,000 chemical substances providing information such as registry numbers from Chemical Abstract Service, molecular formulas, generic names, and where applicable, ring information.

RTECS Contains toxicity data for more than 70,000 substances providing a single source for basic toxicity information. Can be searched by chemical identifiers, type of effect, or other criteria.

TOXLINE. Bibliographic citations covering the toxicological, pharmacological, biochemical, and physiologic effects of drugs and other chemicals.

TOXNET. A computerized system of toxicologically oriented data reviewed, edited, and evaluated scientifically. Contains information related to the environment, emergency situations, safety and handling, and regulatory issues for over 4100 chemicals. In addition, information on carcinogenicity, tumor promotion, and mutagenicity test results for over 1000 chemicals is available.

TABLE 9. DATA BASE OBJECTIVES

- Assess the past and present quantity and types of hazardous wastes generated and currently disposed of in Illinois.
- Provide a referral service for hazardous waste assistance and services at the state and federal levels.
- Assemble an engineering data base on current and developing hazardous waste treatment, recycling, and management technologies.
- Provide projections of expected waste types and amounts from past trends and types of products produced in Illinois.
- Determine differences between estimated waste generation and the amount manifested for off-site treatment.
- Perform literature searches of hazardous waste research and other information in publications.
- Track samples as they are processed in the Hazardous Materials Laboratory.
- Develop various simulation models, including ones assessing economic issues associated with hazardous waste management, transport, and fate of hazardous wastes in the environment, and statewide hazardous waste management.
- Inventory of environmental information on state hazardous waste sites and various media such as water, land, and air.
- Identify possible sources of environmental and health risks from exposure to hazardous wastes.
- Identify public water supplies that are in close proximity to hazardous waste sites or draw water from an aquifer that is threatened by hazardous wastes.
- Account for hazardous wastes that are generated outside of Illinois and are treated, stored, or disposed of in the state.
- Maintain current information on toxicological and environmental effects of hazardous wastes and their constituents.
- Access detailed information on specific hazardous wastes related to chemical properties, incompatibilities, personnel protection, symptoms of exposure, leak and spill procedures, disposal methods, and regulatory status.

TABLE 10. DATA DEVELOPMENT AND ENHANCEMENT PROJECTS

Purpose/Functional Element

Projects

- | | |
|---|--|
| Build and Assess the Data Base: | <ul style="list-style-type: none"> . Initiation of Potentially Hazardous-Waste-Related Inventory. . Statewide Hazardous Waste Generation Study. . Enhancement of the potentially Hazardous Waste-Related Activities Inventory. . Statewide Landfill Inventory. . Evaluation of Current ground Injection of Industrial Waste in Illinois. . Historical Waste Generation and Disposal Practices. . Industrial Wastes in the Area, 1869-1970: An Historical Geography. . Historical Patterns of Hazardous Waste Management: Winnebago County 1870-1980. . Historical Assessment of Hazardous Waste Management in St. Clair and Madison Counties, Illinois: 1890-1980. . Development of Hazardous Waste Management Model for Illinois. |
| Defining the Degree-of-Hazard of Specific Wastes: | <ul style="list-style-type: none"> . Enhancement of the Hazardous Waste-Related Activities Inventory. . Special Waste Categorization Study. |

Table 10. Continued

Environmental Monitoring and Acquisition:

Assemble Engineering Data Base on Technologies and Practices:

Toxicological and Environmental Effects from Hazardous Wastes:

Environmental Transport of Hazardous Chemicals and Wastes

- . Determining the Degree-of-Hazard of Waste Streams in Illinois.
- . Refining the Degree of Hazard Methodology
- . Organics in Fine Grained Data Materials at Wilsonville, Illinois.
- . Atmospheric Research and Monitoring Study of Hazardous Substances.
- . Regional Ground Water Quality Characterization of the Rockford Area, Illinois.
- . Feasibility of a Central Recovery Facility for the Metal Finishing Industry in Cook County (Metropolitan Sanitary District of Greater Chicago).
- . Feasibility of Ion-Exchange as an Appropriate Self-contained Waste Minimization Process for the Electroplating Industry.
- . Summary of Toxicological Data for Aquatic Organisms of Illinois.
- . Assessment of Ecotoxicological Hazard of Waukegan Harbor Sediments.
- . Assessment of Environmental Hazard in Lake Calumet
- . Levels of PCBs and Trace Metals in Crab Orchard Lake Sediment and Biota.
- . Ground Water Impact and Fate Assessment of Containment Migration Through Typical Surficial Geologic Sequences in Illinois.

TABLE 11. HWRIC DATA BASE SOURCE FILES

<u>DATA SOURCE/File name</u>	<u>Date Received</u>
IEPA	
Selected Inventory	11/08/84
Update	11/08/85
Update	2/10/87
1982 Annual Hazardous Waste Report	11/08/84
1983 Annual Hazardous Waste Report	11/08/84
1984 Annual Hazardous Waste Report	11/08/85
1985 Annual Hazardous Waste Report	2/10/87
Waste Disposal Application Master	12/28/84
Update	11/08/85
Update	2/10/87
Generic Waste Stream Master	12/28/84
Manifest History 1982	12/28/84
Manifest History 1983	12/28/84
Manifest History 1984	11/08/85
Manifest History 1985	2/10/87
Water Quality Standards Master	11/08/84
Update	2/10/87
Water Quality Analysis Master	11/08/84
Update	11/08/85
Update	2/10/87
Permit Conditions Master	11/08/84
Update	2/10/87
NTIS	
RCRA	10/18/84
Update	1/15/86
CERCLA (Superfund)	09/01/84
Update	12/15/86
USEPA	
Surface Impoundment Assessment	10/19/84
GCMSD	
Greater Chicago Metropolitan Sanitary District	10/15/84
DUN & BRADSTREET, Inc.	
Dun's Market Identifiers	04/15/85

TABLE 12. HWRIC DATA BASE FILE DESCRIPTIONS

File Name	Description
Selected Inventory	List of facilities regulated by IEPA with name, address, and activity information.
Annual Hazardous Waste Report	Information on RCRA hazardous, waste sources, amounts, handling and disposal methods.
Waste Disposal Application Master	Information submitted by TSD facilities in request of a permit to dispose of wastes from a specific generator, including projected quantities, waste types, and characteristics.
Generic Waste Stream Master	Information submitted in request of a disposal permit for wastes from multiple (generic) generators.
Manifest History	Records of chain-of-custody for wastes from source to destination.
Water Quality Standards Master	Quality criteria for drinking water and standards for general uses.
Water Quality Analysis Master	Water quality data from groundwater and surface water monitoring at RCRA sites.
Permit Conditions Master	Site information and reporting requirements for waste disposal sites that must monitor local groundwater quality.
RCRA	Generator, Transporter, and TSD facility information on hazardous waste activities, including waste types, handling, and transportation modes.
CERCLA	Information on sites where hazardous substances were stored, treated, or disposed, with waste types and amounts.

Table 12. Continued

Surface Impoundment Assessment	Locations, physical and operational features of all surface impoundments as of 1978.
Greater Chicago Metropolitan Sanitary District	List of facilities that discharge waste into the Chicago sanitary sewer system, with locational and activity information.
Dun's Market Identifiers	Businesses that have requested a credit rating through Dun and Bradstreet, including name, address, and activity.

TABLE 13. HWRIC DATA BASE FILE CONTENT

FILE CONTENT

FILE NAME	Generator, TSP, Transporter Identification	Geographic Location	Type of Activity	Waste Characteristics	Waste Quantities	Waste Handling/Disposal Methods	Compliance Information
Selected Inventory	X	X	X	X			X
Annual Haz. Waste Rpt. (1982-85)	X			X	X	X	
Waste Disposal Application Master	X		X	X	X	X	X
Generic Waste Stream Master	X			X		X	
Manifest History (1982-85)	X			X	X	X	
Water Quality Standards Master							X
Water Quality Analysis Master	X			X			
Permit Conditions Master	X						X
RCRA	X	X	X	X		X	
CERCLA (Superfund)	X	X		X	X		
Surface Impoundment Assessment	X	X	X	X			
Greater Chicago Metropolitan Sanitary District	X	X	X				
Dun's Market Identifiers	X	X	X				

TABLE 14. Data Files and Information Related to Companies Practicing Incineration in Cook County, Illinois.

Annual Hazardous Reports for 1984

SCA Chemical Services	Chicago	0316000058
-----------------------	---------	------------

Waste Disposal Application Permits

McKesson Envirosystems	Dolton	0310690006
Cremation Services Inc	Rosemont	0312760001
American Incineration Inc	Chicago	0316000031
US Drum Disposal	Chicago	0316000035
Envirothem	Chicago	0316000043
SCA Chemical Services	Chicago	0316000058

Generic Waste Disposal Permits

SCA Chemical Services	Chicago	0316000058
Christ Community Hospital	Oak Lawn	0312220002
Augustana Hospital	Chicago	0316070003

Selected Inventory Treatment Segment
(Disposal method T06 to T18)

SCA Chemical Services	Chicago	0316000058	T18
Christ Community Hospital	Oak Lawn	0312220002	T18
Augustana Hospital	Chicago	0316070003	T18
Cremation Services Inc	Rosemont	0312760001	T18
Goose Island	Chicago	0316080003	T18

no disposal method listed

American Incineration Inc	Chicago	0316000031
---------------------------	---------	------------

Dates and Number of Waste Streams
From Waste Disposal Applications Master
(For Streams not found in Selected Inventory)

Name Streams	Illinois ID	Dates	No.
McKesson Envirosystems	0310690006	6/25/82 to 7/14/82	1
US Drum Disposal	0316000035	1980 to 1981	14
Envirothem	0316000043	2/20/80 to 2/20/81	1

TABLE 14. Continued

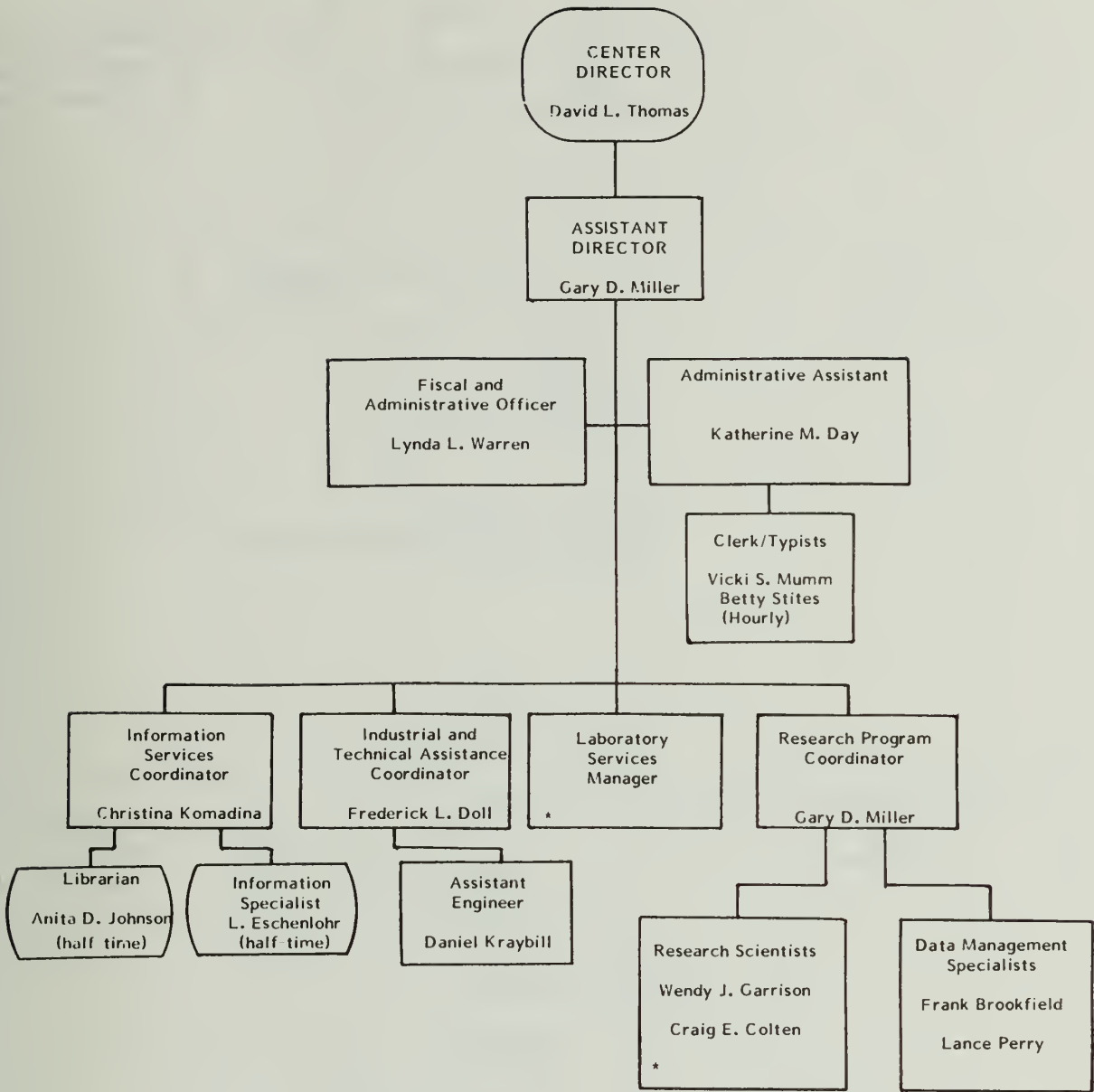
Companies Listed As Incinerators

SCA Chemical Services	Hazardous waste >1000 kgs mo 1984
Christ Community Hospital	Hazardous waste <1000 kgs mo.1984
Augustana Hospital	" "
Cremation Services Inc	Special Waste
American Incineration Inc	" "
Goose Island	Municipal incinerator no Special waste
McKesson Envirosystems	Miss-coded in Waste Disposal Master
Envirothem	" "
US Drum Disposal	Incinerator 1980-1981 some Hazardous waste now a landfill

USEPA Handling Codes for Thermal Treatment

T06 Liquid injection incinerator
 T07 Rotary kiln incinerator
 T08 Fluidized bed incinerator
 T09 Multiple hearth incinerator
 T10 Infrared furnace incinerator
 T11 Molten salt destructor
 T12 Pyrolysis
 T13 Wet Air oxidation
 T14 Calcination
 T15 Microwave discharge
 T16 Cement kiln
 T17 Lime kiln
 T18 Other (specify)

FIGURES



* These positions will be filled in FY '87

HWRIC MANAGEMENT STRUCTURE FOR FY '87

HWRIC is administered by the Illinois State Water Survey Division of the Department of Energy and Natural Resources

FIGURE 1. HWRIC Management Structure for FY'87

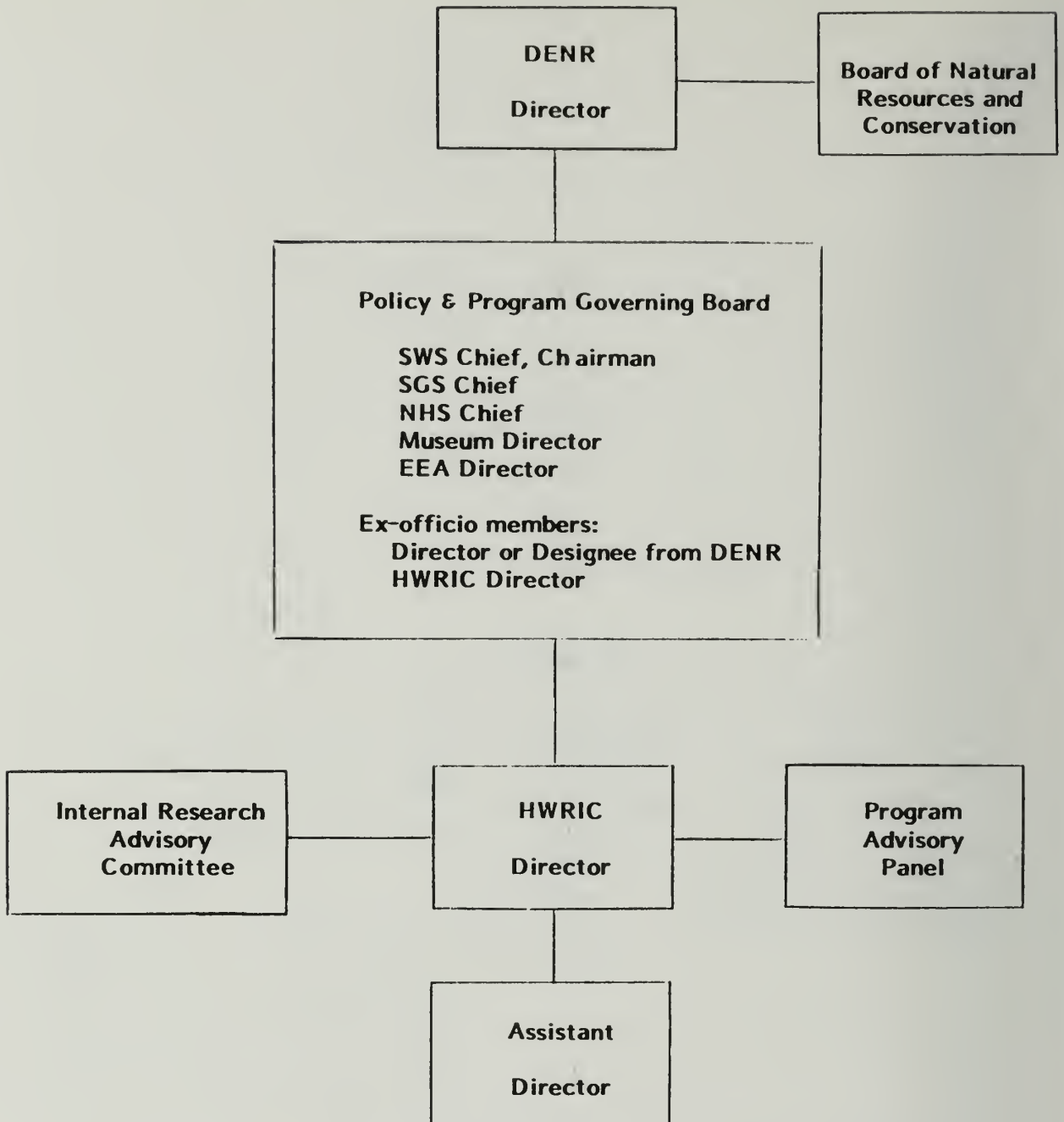


FIGURE 2. Administrative Structure of HWRIC

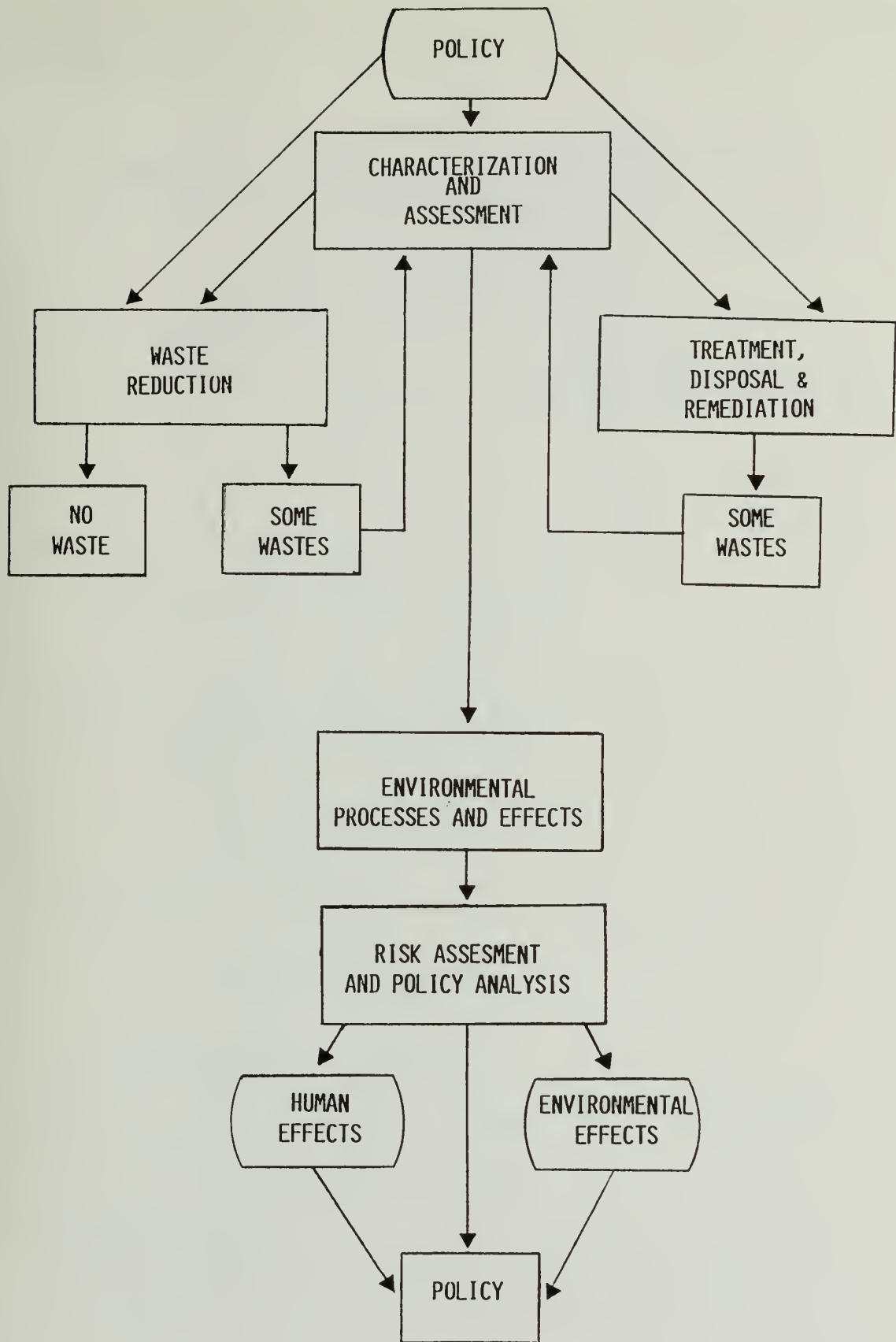


FIGURE 3. RELATIONSHIPS BETWEEN HWRI'S FIVE RESEARCH AREAS AND POLICY MAKING.

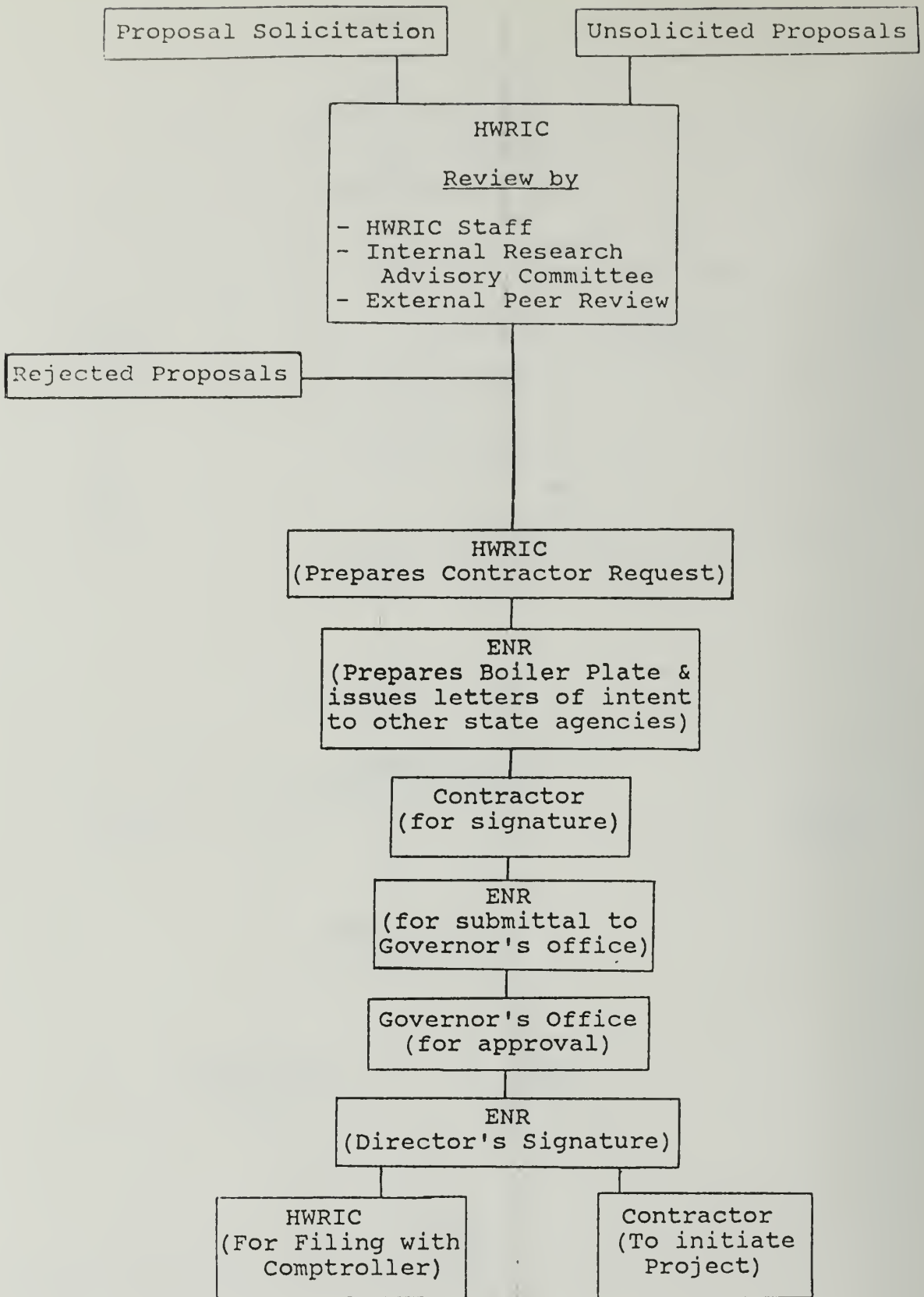


FIGURE 4. Flow chart for Proposals & Contracts

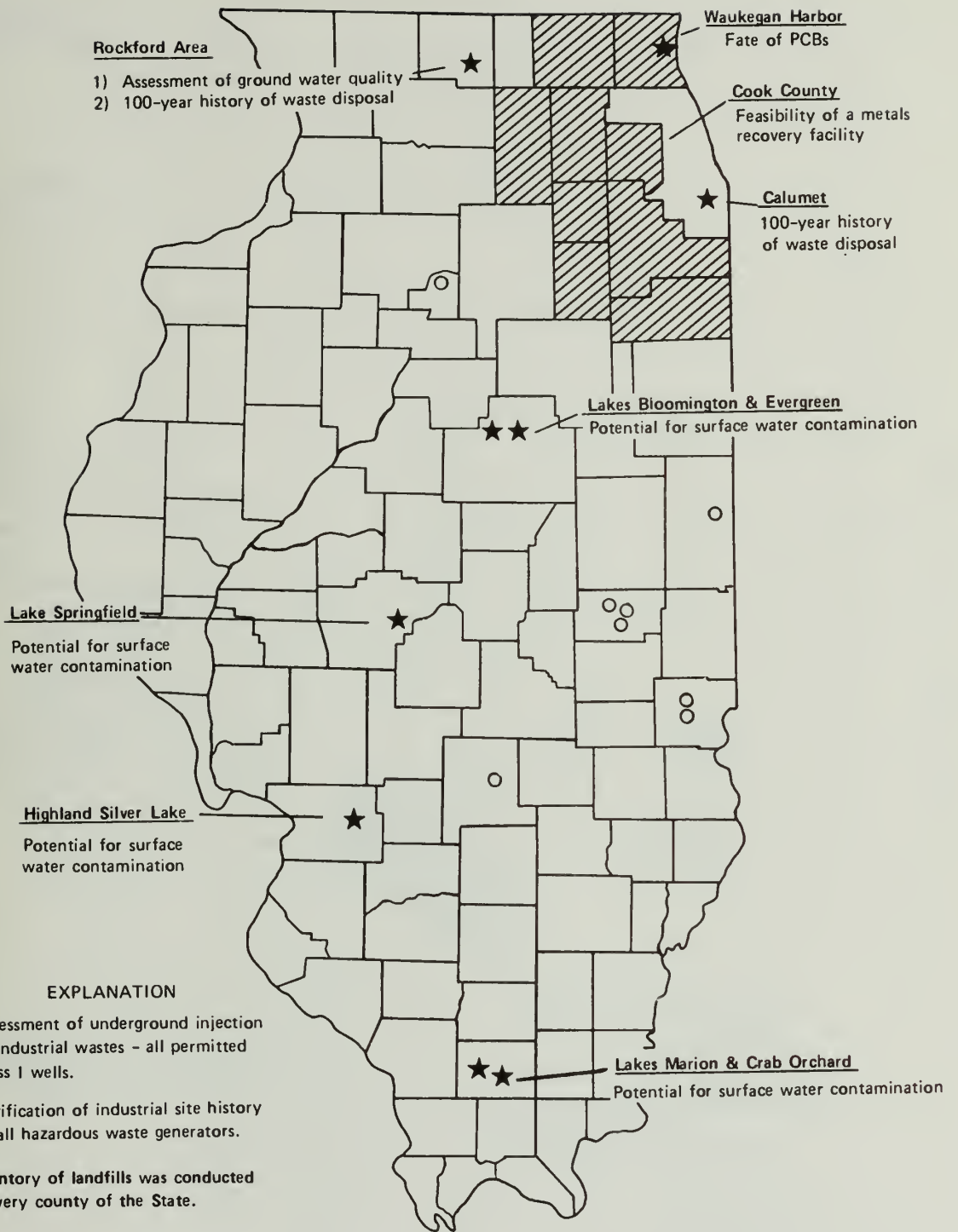


FIGURE 5. HWRIC Field Studies, Completed

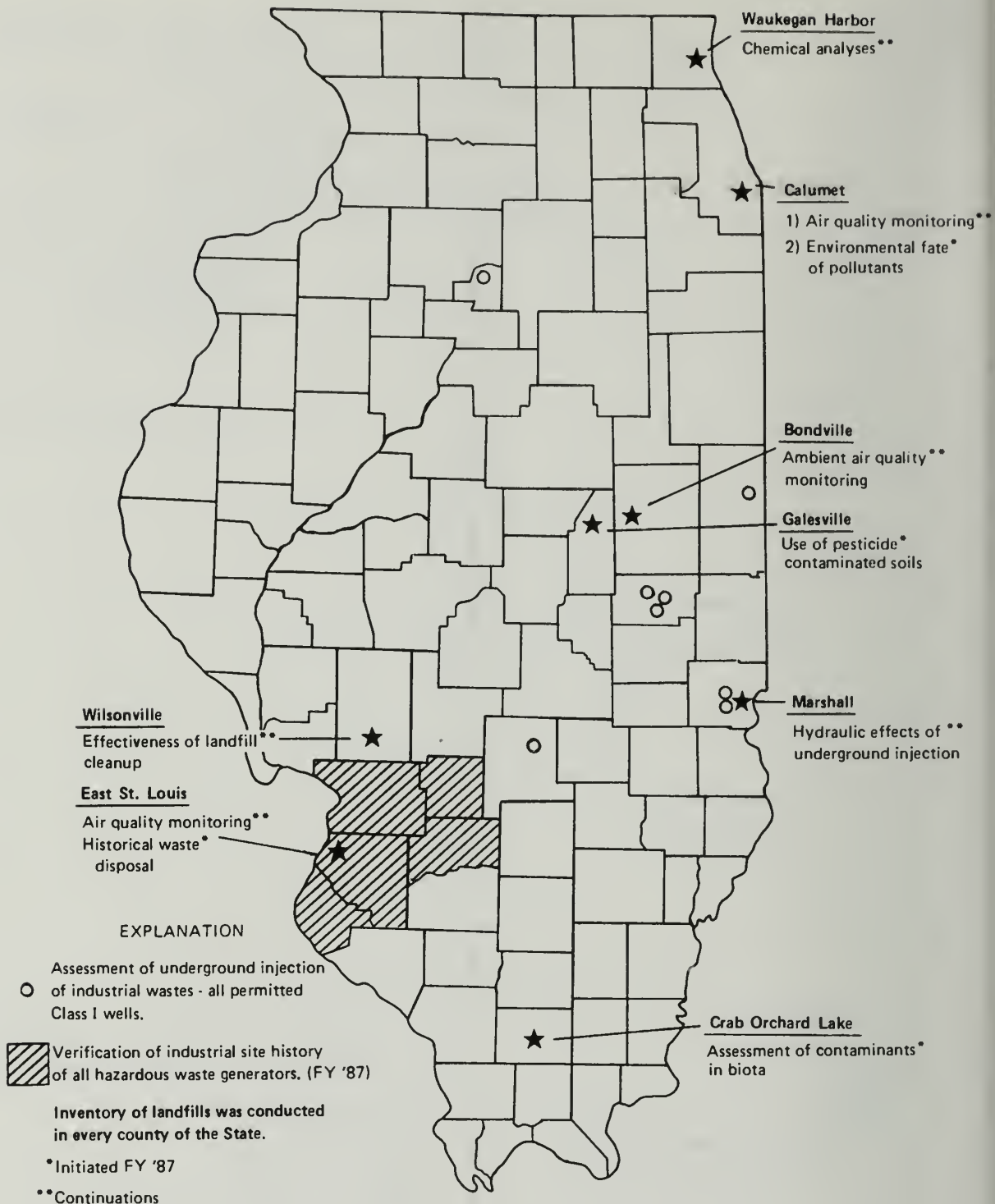
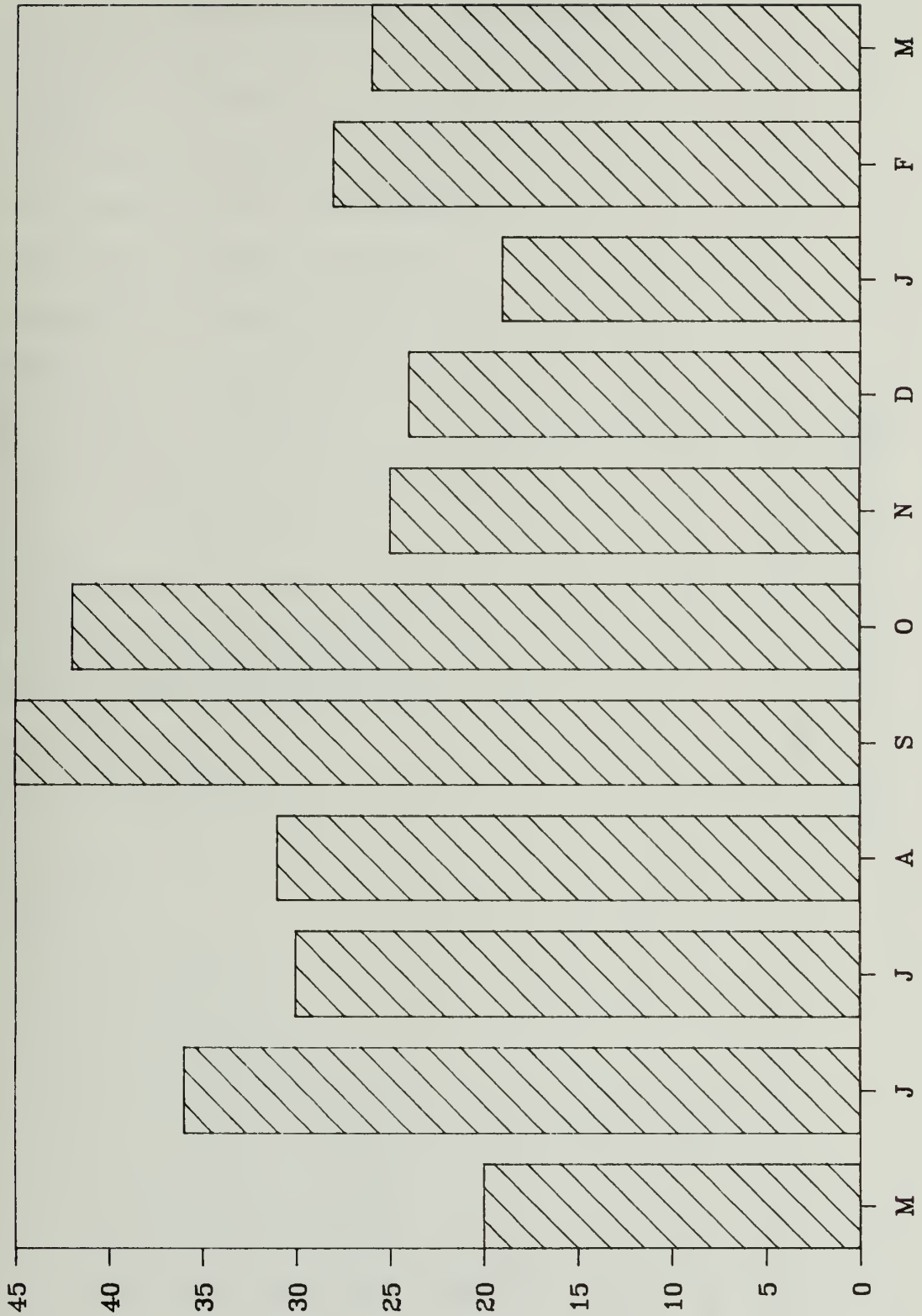


FIGURE 6. HWRIC Field Studies, Initiated in FY'87 and Continuing Projects

ITA ACTIVITIES

Instances of Technical Assistance

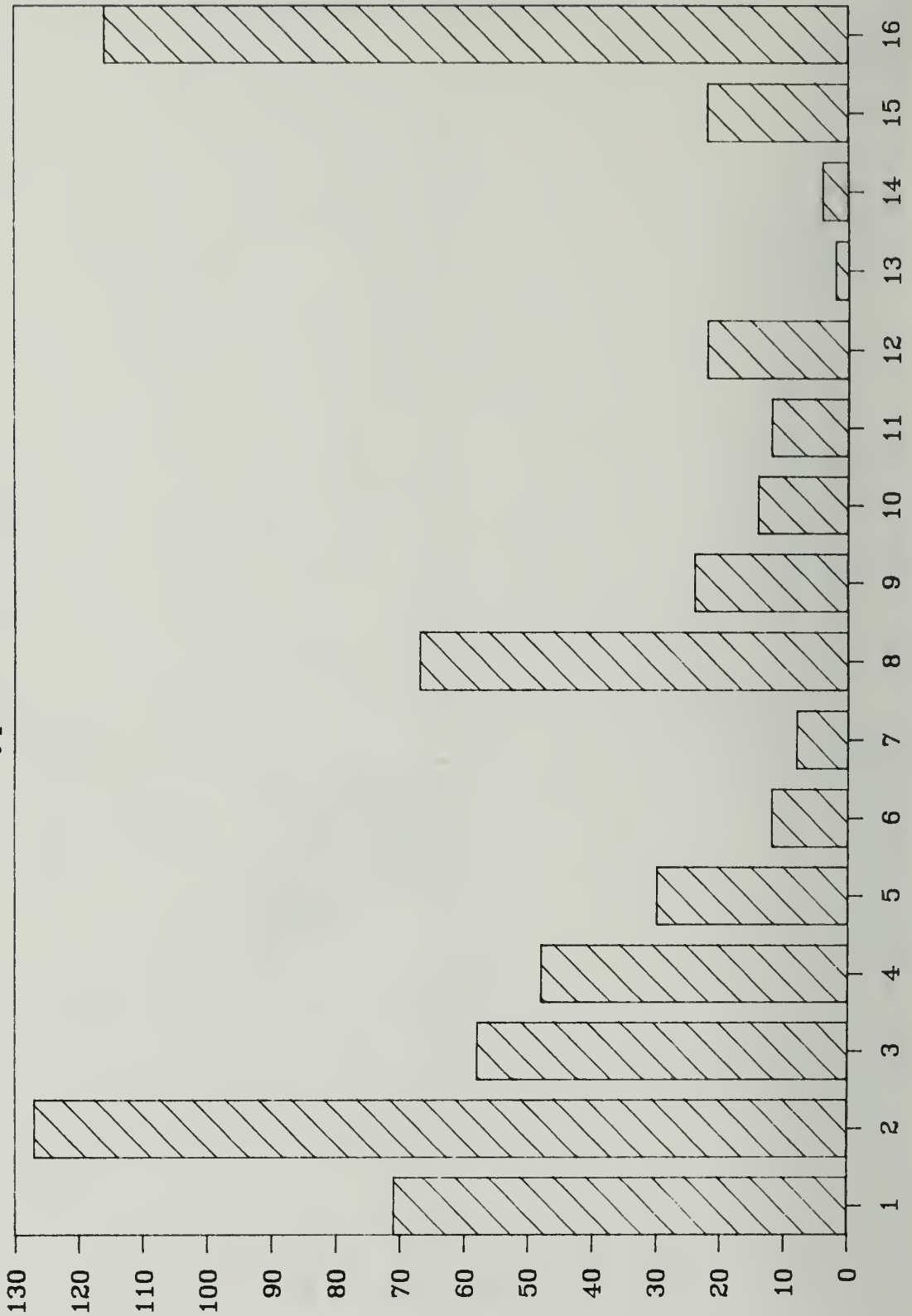


May, 1986 - March, 1987

FIGURE 7. ITA Activities - Instances of Technical Assistance

ITA ACTIVITIES

Types of Assistance



(See Key on Following Page)

FIGURE 8. ITA Activities - Types of Assistance

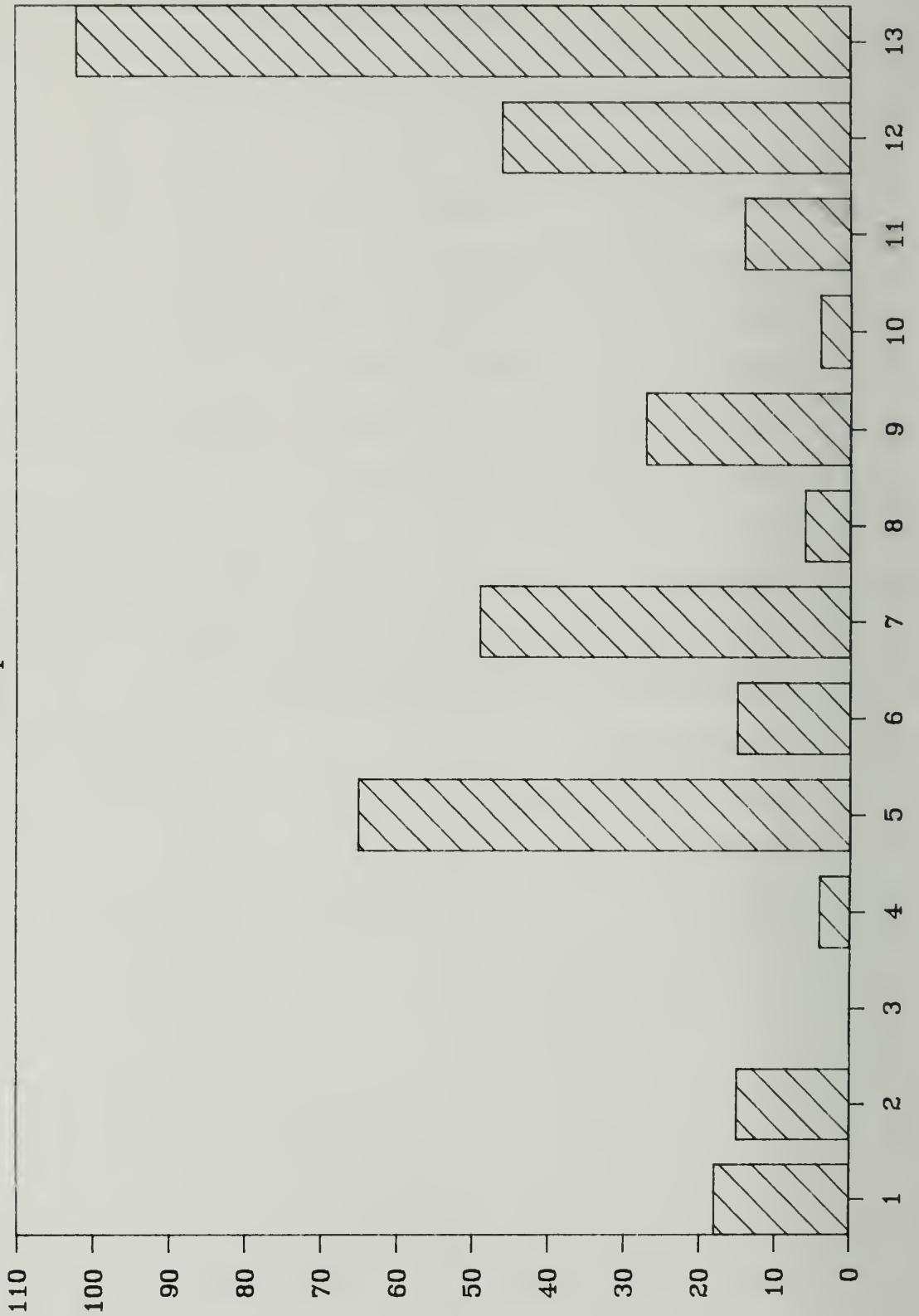
Key to Figure 8

TYPE OF ASSISTANCE

1. Information on Existing Regulations
2. Information on HWRIC Programs
3. Information on New Regulations
4. Reference to Disposal Firms
5. Reference to Consultants or Laboratories
6. Reference to Equipment Vendors
7. Reference to Industrial Materials Exchange Service (IMES)
8. Direct Technical Assistance
9. On-site Consultation
10. Information on Waste Reduction & Minimization
11. Information on Alternative Technologies
12. Information on Right-To-Know (RTK)
13. Recordkeeping
14. Hazardous Materials
15. Training
16. Other

ITA ACTIVITIES

Groups Assisted



(See Key on Following Page)

FIGURE 9. ITA Activities - Groups Assisted

Key to Figure 9

TYPE OF GROUP ASSISTED

1. Trade Association
2. Communities
3. Farmers
4. Agricultural Groups
5. Other Agencies
6. Vendors
7. Small Quantity Generators
8. Very Small Quantity Generators
9. Schools
10. Hospitals
11. Individuals
12. Large Quantity Generators
13. Other

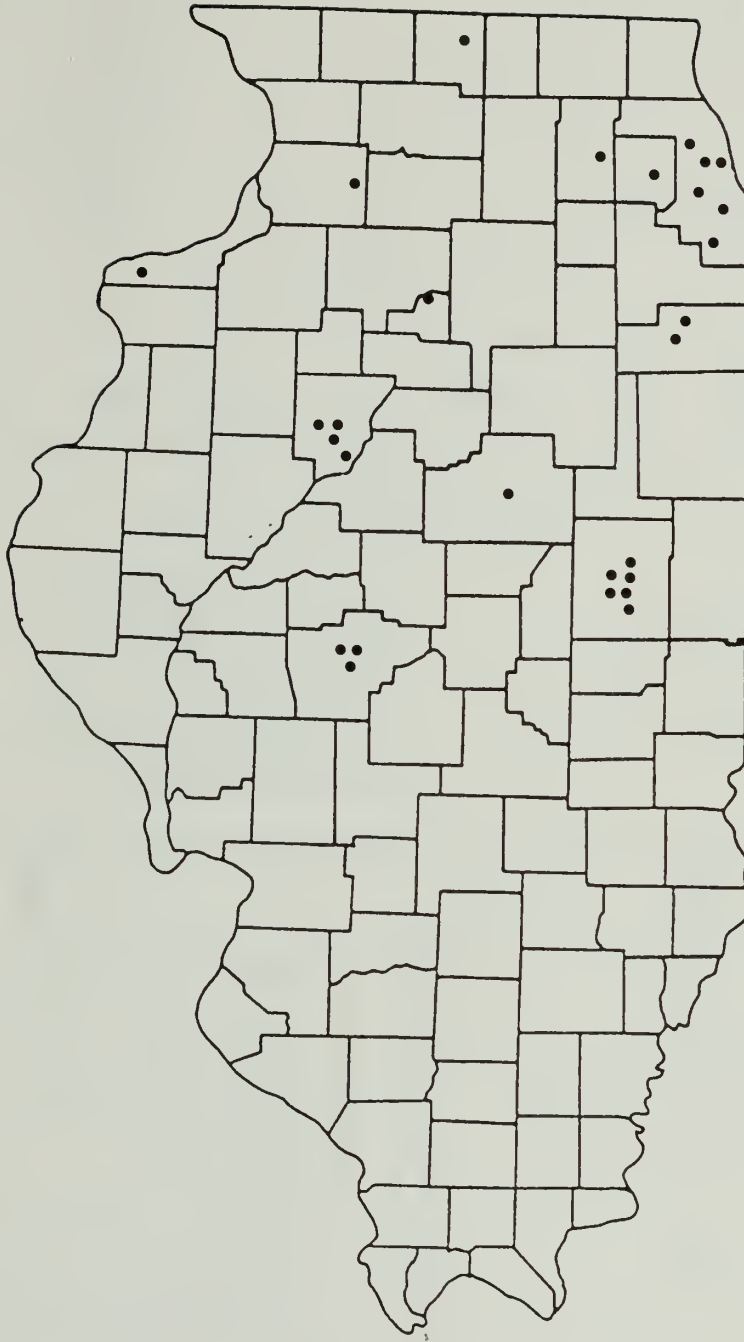


Figure 11. ITA Speaking Engagements
April 1986 - April 1987

INFORMATION COLLECTION AND DISSEMINATION

INFORMATION SOURCES

- .Books
- .Government Reports and other documents
- .Journals
- .Newsletters
- .Fact Sheets
- .Handbooks
- .Reference Material
- . HWRIC Research Reports
- . HWRIC ITA Program
- . HWRIC Data Base
- . HWRIC-Sponsored Research
- . Government Data Bases
- . Outside Libraries
- . Computerized Data Bases

HWRIC LIBRARY AND CLEARINGHOUSE

MEANS OF DISSEMINATION

- .Telephone
- .Written Querries
- .HWRIC Research Reports
- .Newsletter Articles
- .Press Releases
- .Individuals using Library at Center
- .Talks
- . Seminars/Workshops
- . HWRIC's Technical Publications
- . Information Packets on Specific Topics
- . Clearinghouse Materials
- . Interviews Media
- . Radio programs
- . Newspaper articles
- . Research Summaries

USER GROUPS

- . State & Federal Government
- . Local Governments
- . Policy Makers & Planners
- . State Legislators
- . Illinois Congressional Delegation
- . Researchers from:
 - State Agencies
 - Universities
 - Industries
 - Consulting Firms
- . Public Interest Groups
- . Environmental Groups
- . Educators - Public Schools
- . Industry/Businesses
- . Mass Media

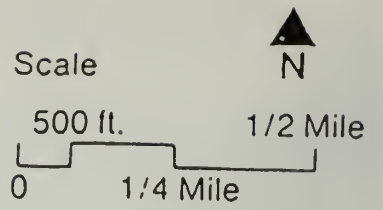
USES OF INFORMATION

- . Planning & Policy Making-- State and Local Level
- . Technology Development
- . Research
- . Education
- . Public Information and Education
- . Waste Reduction
- . Compliance with Regulations
- . Drafting Legislation/Regulations
- . HW Facility Siting
- . Environmental Audits
- . Characterize Hazardous Waste Problems
- . Industrial Audits
- . Enforcement
- . Economic Development

FIGURE 12. Information Collection and Dissemination



Figure 13. Locations of listed and proposed National Priority List (NPL) sites and State Remedial Action Priority List sites (SRAPL) in Illinois.



Local Context

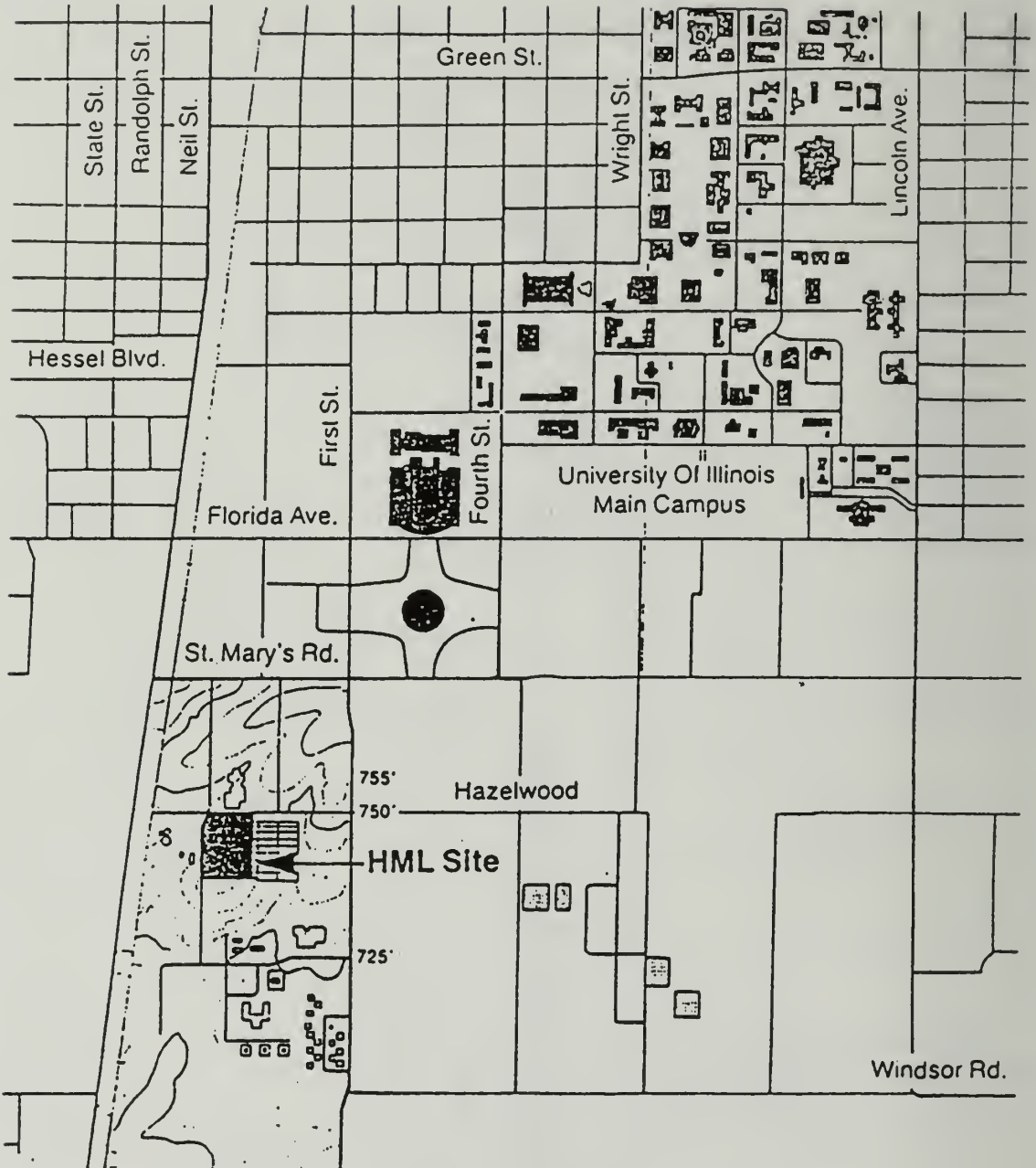


FIGURE 14. Location of HML on South Portion of UI Campus

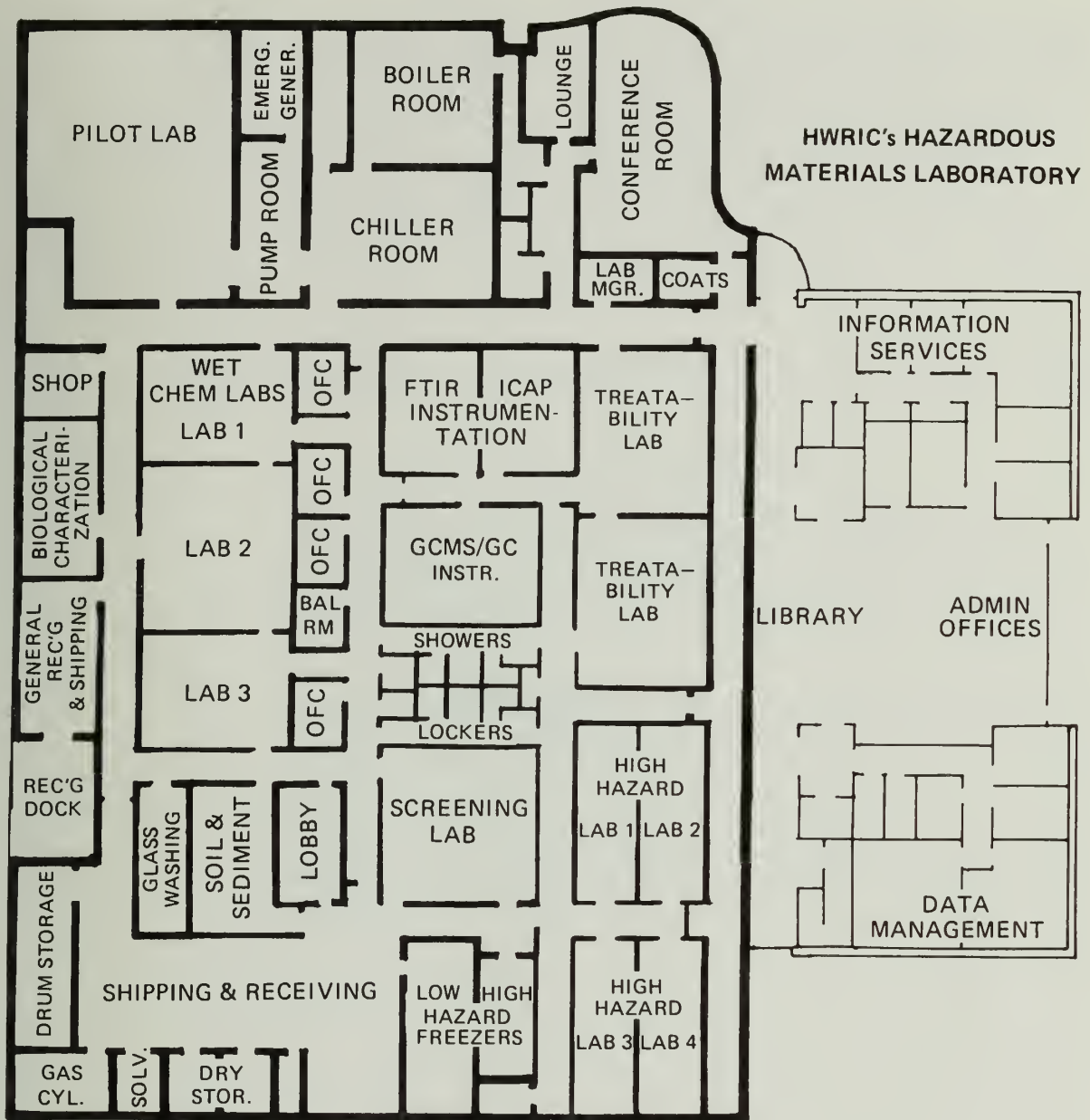


FIGURE 15. HML First Floor

APPENDIX I

APPENDIX I

HWRIC GOVERNING BOARD

The HWRIC Governing Board was established to oversee the overall management of HWRIC. It consists of the head of each DENR Division, which includes the Chiefs of the three Scientific Surveys, the Director of the State Museum, and the Director of the Environmental and Energy Affairs Division. Principal activities of the Governing Board include a) setting major policies relating to HWRIC; b) reviewing and approving annual reports and future plans of HWRIC; c) approving of the budget and funding plans; and d) approving employees hired for all key staff positions.

Below is a list of all Governing Board meetings held between May 1, 1986 - April 30, 1987 and the main topics discussed during the meetings.

<u>DATE</u>	<u>MAIN TOPICS OF DISCUSSION</u>
05/30/86	ITA and Research Programs update, MacArthur Foundation Proposal status, Solid Waste Initiative, Data Management Program review, HML update, staffing, FY'87 Program Plan, FY'88 and FY'87 budgets status.
08/13/86	Staffing, FY'87 Program Plan, publication policy, budget initiatives, FY'88 preliminary budget, MacArthur Foundation Proposal, and hook-up between DENR and HWRIC's Prime computers.
02/25/87	Proposal solicitation status, Management Plan, roles of Governing Board & advisory bodies, publication policy, Waste Reduction Program, HML update, and staffing.

HWRIC GOVERNING BOARD

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Secretary: Alice

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785-2003
Secretary: Sheila

Mr. Mitch Beaver, Director
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Secretary: Wanda

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HWRIC RESEARCH ADVISORY COMMITTEE

The main function of the HWRIC Research Advisory Committee is to provide research advice to the Director and Research Program Coordinator to assist them in designing HWRIC's Research Program. The Committee consists of one representative from each division of DENR. The Committee also helps coordinate research projects within the DENR divisions, reviews proposals sent to HWRIC, and aids in the decision of which proposals will be funded.

Below is a list of the Research Advisory Committee meetings held between May 1, 1986 - April 30, 1987 and the main topics of discussion at each meeting.

<u>DATE</u>	<u>MAIN TOPICS OF DISCUSSION</u>
10/31/86	Transfer of divisional staff, RRT Matching Grant solicitation status, status of FY'86 reports, progress on FY'87 Projects, HML update, FY'88 goals, MacArthur Foundation Proposal status.
01/06/87	New staff and organization, role of Committee, proposal reviews, status of current projects, former divisional staff roles, FY'88 preproposals status, matching grants program status, new projects for FY'87 funds.
03/05/87	HWRIC Management Structure document status, new ENR contracts form, HML update, status of Laboratory Manager and Research Scientist positions, midyear review reports, projects to be funded before end of fiscal year, matching grants program, proposal review process.

RESEARCH ADVISORY COMMITTEE

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333-5113, Secretary (3-5106)

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HWRIC PROGRAM ADVISORY PANEL

The HWRIC Program Advisory Panel's primary function is to provide an external source for advice on HWRIC's overall program -- how HWRIC can help industry with their hazardous waste management problems and provide hazardous waste information to the public. The Panel consists of representatives from industry, state government, academia, and outside public interest groups.

Below is a list of the main topics discussed at the meeting held on June 23, 1986.

<u>DATE</u>	<u>MAIN TOPICS OF DISCUSSION</u>
06/23/86	Staffing update, FY'87 budget status, HML update, programs update.

HWRIC ADVISORY PANEL MEMBERS

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two years
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312/939-1984 (Admin.)

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Scientific Control Labs
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two years
312/254-2406

Mr. Mark Kuechler
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two years
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Dr. Dimitrios Moschandreas
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Dr. John Marlin*
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312/922-6575

* Second year of 2-year appointment

HWRIC Advisory Panel, Continued

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two years
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* second year of 2-year appointment

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APPENDIX II

APPENDIX II: HWRIC RESEARCH PROJECT SUMMARIES

Characterization and Assessment

Statewide Hazardous Waste Generation Study by Raghu Raghavan, Environmental Resources Management, Inc. FY'85.

The Statewide Hazardous Waste Generation Study identifies and catalogs individual hazardous waste streams generated in Illinois that are regulated under RCRA as well as some that are exempt from RCRA. Some physical and chemical characteristics of waste streams are presented along with the industrial processes that generate them. Waste generation factors for economic forecasting, and assessment of the relative hazards of different wastes are studied and discussed. This research generated updated and expanded data bases on hazardous waste generation and management in the State.

Initiation of the Hazardous Waste Research and Information Center Data Base by Susan C. Schock, Hazardous Waste Research and Information Center and Illinois State Water Survey. FY'85.

The sources for the data base are the Illinois Environmental Protection Agency, RCRA and CERCLA data from the National Technical Information Service (NTIS), the U.S. Environmental Protection Agency, the Chicago Metropolitan Sanitary District, and the Dun's Market Identifiers from Dun and Bradstreet. Data from these sources were matched and combined to form the Hazardous Waste Research and Information Center (HWRIC) database.

The HWRIC database contains site information on facilities that handle hazardous wastes. It will be one of the basic research tools available for hazardous substances related research projects. Attachment I shows information available.

Enhancement of the Hazardous Waste-Related Activities Inventory by Susan C. Schock, Hazardous Waste Research and Information Center and Illinois State Water Survey. FY'86-87.

A data base of hazardous waste generators and disposal facilities in Illinois is being augmented with data that allows better classification of activity type, exact location, and size of facility. Historical records are being consulted to determine the duration of activities involving hazardous wastes at a particular site. Point location information is being acquired requiring locating sites on maps and calculating the township, range and section for the site. The first year of this 3 year research effort will establish the methodology and acquire the information for nine counties in the northeast 1/3 of the State.

Statewide Landfill Inventory by William G. Dixon, Jr., Illinois State Geological Survey. FY'85, 86, 87.

To accurately assess the magnitude and extent of the hazardous waste problem in Illinois, it is necessary to identify the locations and characteristics of waste disposal sites,

both past and present. This statewide inventory contains information on all known landfill, land application, and impoundment waste disposal sites in Illinois. It includes data on the types of wastes disposed, the hydrogeologic setting, waste source(s), and background data (site history, previous studies, and records of operation and monitoring). The site locations are digitized into a computer mapping system which displays the waste disposal activities throughout the State and indicates relative groundwater concerns.

The continuation of this study will result in a map for each county showing for each site identified type of waste disposal and its status, whether active or inactive. It will also include a prioritization of landfills that could potentially leach contaminants into ground water.

Special Waste Categorization Study by K. R. Reddy, Energy and Environmental Affairs Division, Dept. of Energy and Natural Resources. FY'85.

The definition of "Special Wastes" in the State of Illinois includes federally regulated hazardous waste (those covered by the Resource Conservation and Recovery Act - RCRA), all industrial process waste, and pollution control waste. Under the current environmental regulations system, all special wastes, regardless of how dangerous they are, have similar permitting requirements for transportation and disposal. It is believed by many that differences in health and environmental risks posed by hazardous and non-hazardous waste streams are not adequately acknowledged in the regulation of special wastes. In this study a system has been designed to classify Illinois special wastes by the degree of hazard posed to human health and the environment. The technical analysis and categorization of various waste streams provides a basis for the modification of existing regulations or the proposition of new regulations in the management of special wastes in Illinois.

Industrial Wastes in the Calumet Area, 1869-1970: An Historical Geography by Craig E. Colten, Hazardous Waste Research and Information Center and Illinois State Museum. FY'85.

The historical geography of the Lake Calumet area in southeast Chicago was studied in an effort to ascertain the location and quantity of industrial waste disposal from 1869 to 1970. Since 1869, Lake Calumet has been the scene of heavy manufacturing activity, and because of marshy conditions, has been the site of extensive industrial waste disposal.

A chronology of waste disposal techniques was developed through the use of historical methods. Through an analysis of historical documents, changing patterns of land use were mapped, the location of disposal sites was determined, and the composition of waste streams was identified.

This study documents the major patterns of waste disposal before 1970. Generally, industries discarded unwanted wastes in the nearest streams or on low ground; this caused sedimentation in the Calumet River, degradation of the surrounding wetlands and lakes, and tainting of Chicago's drinking water.

The Calumet study indicates that hazardous substances are present in the soil and in buildings, although the exact levels of concentrations are not known. As the modernization of the Calumet industrial complex gets underway, the demolition and reconstruction of old factory sites could conceivably disturb accumulated wastes, and expose workers and area

residents to unrecognized risks. The possibility of gradual release to the environment also remains.

Historical Patterns of Hazardous Waste Management in Winnebago County, Illinois: 1870-1980 by Craig Colten, Hazardous Waste Research and Information Center and Illinois State Museum. FY'86.

The historical patterns of waste disposal in Winnebago County during the period 1870 to 1980 will be studied to assess the potential threat posed to selected water supplies today due to improper disposal of industrial wastes in the past.

The study consists of two inter-related investigations: A historical geography of industrial activity in the area and an analysis of past water pumpage records. Historical maps of industrial activity will be generated and combined with contemporary maps of Winnebago County's water wells and ground water flow patterns. These maps will be overlaid to indicate the location of potential ground water contamination from industrial wastes. By combining a study of water well use with the history of industrial waste disposal practices, this study will help to document past and potential ground water pollution locations in the county. This complements ground water quality research in the Rockford area also being partially funded by HWRIC.

Regional Ground Water Quality Characterization of the Rockford Area, Illinois by Thomas R. Holm and Allen H. Wehrmann, Illinois State Water Survey, and Richard C. Berg, Illinois State Geological Survey. FY'86.

A ground water quality study in the northern Illinois Rockford area is underway to identify and quantify hazardous chemicals in ground water and link them to the occurrence of hazardous waste related activities. This study addresses the current hydrogeologic conditions and reviews existing data on ground water quality. A conceptual hydrogeologic model will be developed to interpret the interrelationships of the geology and water use patterns to ground water and contaminant movement. Historical water quality and hazardous waste activity information will be evaluated to identify areas of known, suspected or predicted contamination.

Potential Hazardous Waste Contamination of Illinois Surface Water Supplies by G. Michael Bender and Cheri A. Chenoweth, Illinois State Water Survey. FY'86.

The potential for accidental or inadvertent introduction of hazardous waste into surface water and events which could, in turn, threaten public water supplies, are examined. The dominant threat to any surface water supply would appear to come from stationary sites of hazardous waste-related activity, which might release hazardous materials into a lake or upstream from a water withdrawal point in a river. However, the limited state control of routes for transporting hazardous materials suggests that any surface water supply may be endangered by moving sources, i.e., trains, barges, and/or vehicles on highways.

This research project will inventory 133 public surface water supplies in the state. In addition, a pilot study will be done for five public water supply reservoirs. It will use the Geographical Information System to map surface water supplies, hazardous waste-related activity locations, and transportation routes.

Historical Assessment of Hazardous Waste Management In St. Clair and Madison Counties, Illinois 1890-1980 by Craig E. Colten, Illinois State Museum. FY'87.

Madison and St. Clair Counties contain the Metro-East St. Louis industrial complex, an area that has been home to primary metal manufacturers, industrial chemical manufacturers, and other hazardous-waste producing industries for nearly a century. The swampy conditions, floodplains, and river meanders, coupled with intense industrial activity for a hundred years make this a high-priority hazardous substance area.

In this study, Dr. Colten is creating a historical narrative of the changing industrial geography of Madison and St. Clair Counties and documenting the waste management techniques used by firms in these counties since 1890. It includes a history of disposal and treatment technologies available during the study period and an analysis of different municipal sanitary sewage treatment facilities available to industries over the years. Waste disposal sites used during the last century will be mapped and ranked according to the suspected hazard they pose.

Dr. Colten has completed two similar projects, one in the south Chicago area of Calumet (HWRIC RR-001) and the other in the Rockford area (HWRIC RR-011). As with these previous studies, the Metro-East St. Louis project will help researchers pinpoint areas needing further environmental analysis, monitoring, and clean-up.

Levels of PCBs and Trace Metals in Crab Orchard Lake Sediment, Benthos, Zooplankton and Fish by Roby C. Heidinger, Director, Cooperative Fisheries Research Laboratory, Southern Illinois University, Carbondale. FY'87.

Crab Orchard Lake has been contaminated with PCBs and trace metals over the 46 years the reservoir has been in existence. High levels of PCBs are present in the ecosystem associated with the Crab Orchard National Wildlife Refuge, and high levels occur in fish taken from the lake. A major source of the PCBs is thought to be the Sangamo dumpsite, the former site of a transformer manufacturing facility. A consulting firm is currently studying the feasibility of a cleanup, but is not planning to do long-term monitoring.

Dr. Heidinger's project involves following temporal changes occurring in PCB levels within selected aquatic ecosystems components before, during, and after the cleanup. He is also monitoring trace metal levels over the same time period. The study will provide information on the ultimate fate of these classes of hazardous wastes in an aquatic system and will evaluate the efficacy of such cleanup efforts.

Evaluation of Current Underground Injection of Industrial Wastes in Illinois by Ross Brower, Illinois State Geological Survey and Adrian Visocky, Illinois State Water Survey. FY'85.

This legislatively mandated project assesses the regulations and practices of the underground injection program for Class I hazardous waste disposal wells in Illinois. The objective of this study is to determine whether underground injection (UIC) is an appropriate method of waste disposal for the state. Recommendations concerning the advisability of UIC are made based on an evaluation of scientific data on several topics: an historic evaluation of the operation and maintenance of UIC facilities; waste and water movement in underground aquifers; reactions between wastes and geological formations with which they come in contact; the structure of target rock formations; and whether

potential natural disasters, specifically earthquakes, may significantly affect waste containment. Based on these assessments, as well as on a comparison of the Illinois program with that in other states, recommendations for the Illinois regulatory program are made.

Atmospheric Research and Monitoring Study of Hazardous Substances by Donald R. Gatz and Clyde W. Sweet, Illinois State Water Survey. FY'85-88.

In this study airborne concentrations of hazardous substances are sampled and analyzed to assess potential harmful health and environmental effects. In particular, two classes of airborne substances derived from hazardous wastes are studied, namely organic compounds and toxic trace elements. Sampling and analytical methods will be developed to test for trace elements and metal concentrations in two particular size classifications. Methods will also be developed to analyze hazardous organic compounds in two general classes that are likely to be present in relatively high concentrations in Illinois air: chlorinated hydrocarbons and aromatic hydrocarbons. Two industrialized sites, Calumet near Chicago and Granite City near East St. Louis, have been chosen for atmospheric sampling. Previous atmospheric monitoring has shown the industrial sites to have high concentrations of airborne iron, manganese, arsenic, and zinc.

Regional Ground Water Contamination in Illinois by John A. Helfrich and Michael J. Barcelona, Illinois State Water Survey. FY'85.

The impact of hazardous waste management on ground water quality poses a potentially serious threat to drinking water supplies. This report analyzes existing ground water data available for Illinois as well as sampling for total organic carbon and specific organic compounds at given locations.

Previous ground water monitoring programs have largely focused on inorganic chemicals. This research effort focuses on monitoring of organic chemicals to identify localized areas of possible contamination. Ground water samples from 61 selected sites in Illinois were collected and analyzed for volatile organic compounds (VOCs) and total organic carbon (TOC). Detectable levels of specific organic compounds were found in public water supply samples where there had been a high level of hazardous waste activity. The results of this study suggest that regional screening of ground water resources that may be vulnerable to contamination from hazardous waste-related activities can be a valuable tool in planning detailed evaluations of ground water quality impact.

Inventory of Hazardous Waste in School Laboratories by Max Taylor, Bradley University, FY'86.

A mail survey inventory of surplus chemicals in public and private senior and junior high schools in Illinois was undertaken during the spring and summer of 1986. This survey was sponsored by IEPA and DENR to plan a combined effort to legally dispose of unwanted hazardous laboratory chemicals.

Approximately 900 schools responded out of an estimated 1440 surveyed, which is a response rate of 62.5 percent. Large amounts of formaldehyde and carbon tetrachloride (over one ton each) were identified as requiring disposal. Smaller amounts of other toxic chemicals such as mercury metal, vinyl chloride, and asbestos were also identified. Large stocks of old, outdated surplus chemicals not on the inventory list were also identified. A chemical exchange program (clearinghouse) was suggested as a possible solution.

Environmental Processes and Effects

Assessment of Ecotoxicological Hazard of Waukegan Harbor Sediments by Philippe Ross, Hazardous Waste Research and Information Center and Illinois Natural History Survey, J. Bruno Risatti, Illinois State Geological Survey, and Michael Henebry, Illinois Natural History Survey. FY'86.

This study will assess, in both chemical and biological terms, the potential risks associated with contaminants that may have accumulated in the sediments of Waukegan Harbor. There are four main tasks included in the project. 1. Sediments will be sampled on a grid of 20 stations and concentrations of metals and PCB's will be determined. These data will be used to generate computerized distribution maps for all contaminants detected, and dispersal patterns will be identified by spatial autocorrelation techniques. 2. Toxicity tests using bacterial, algal and nematode species will be performed on extracts of the sediment samples for comparison. 3. In addition, a community-level bioassay (Protozoan colonization) will be carried out in situ. These tests will be used to determine which areas of the harbor might present especially high environmental risks to the ecosystem. Benthic insect larvae and small fish (if populations are sufficient) collected from the site will be assayed to estimate bioaccumulation factors for selected pollutants. 4. Laboratory measurements of the rates of anaerobic degradation of PCB's will be performed to estimate the residence time of these compounds in undisturbed sediments.

Geochemical Interactions of Hazardous Wastes with Geological Formations in Deep-Well Systems by William Roy, Illinois State Geological Survey. FY'86-87.

Underground injection of hazardous and other industrial wastes is currently a topic of national as well as statewide interest. Many questions need to be answered before it can be determined with any certainty whether underground injection should continue to be accepted as an appropriate waste disposal method. The study addresses the important issue of the compatibility of waste stream components with confining bedrock layers. In the laboratory, Roy and his colleagues will test the reactions of some waste stream components with representative rock samples under elevated temperatures and pressures. This project is co-funded by HWRIC and USEPA.

Phytotoxicity of Waukegan Harbor Sediments by W. Wang, Illinois State Water Survey. FY'86.

The purpose of this project is to assess the toxicity potential of contaminated sediment samples using tests on plants. Bottom sediment is generally considered a sink for environmental pollutants. However, various natural or artificial actions can cause sediment to resuspend and transport and thus create secondary pollution effects. Sediments are also active biological zones and can be an important component of an ecosystem. In this study, sediments from Waukegan Harbor, contaminated to various levels with PCBs, will be investigated in the form of slurry using the duckweed reproduction test and the millet root elongation test. The results of these phytoassay tests will be compared with the results of other tests, using bacteria, algae and nematodes. This information will be used to assess the accuracy of the direct phytoassay methods in determining sediment toxicity.

Development of Sampling Protocol for Organics in Fine Grained Material by Dr. Robert Griffin, Illinois State Geological Survey. FY'86,87.

Since the permeability of fine-grained materials is quite low, the protocol for obtaining water samples from monitoring wells in such an environment differs from that applicable to coarser materials. Because of the common geological characteristics of the site (glacial till), the sampling protocol developed could be applied to many other waste disposal sites in Illinois. This research constitutes part of a continuing investigation of the failure mechanisms and migration of industrial chemicals at the hazardous waste disposal facility originally operated by SCA Service, Inc., at Wilsonville, Macoupin County, Illinois. The outcome of this study will include more complete understanding on migration of organic pollutants at the waste disposal site and how plumes dissipate with time, after cleanup of the site.

Investigation of the Hydraulic Effects of Deep-Well Injection of Industrial Wastes by Edward Mehnert, Illinois State Geological Survey. FY'86-87.

The purpose of this project is to investigate the hydraulic effects of deep-well injection upon the receiving formation and its associated confining layers in the vicinity of the well. A numerical model will be used to study these effects. The model will be calibrated and verified with field data from the Velsicol Chemical Company well. In addition, the monitoring systems used at injection well facilities will be evaluated to verify the adequacy of the existing surface and in-well monitoring procedures and to investigate the possible advantages of and/or need for radial monitoring. This type of information has been determined by USEPA to be essential in order to evaluate the suitability of underground injection for hazardous waste disposal.

An Assessment of the Environmental Hazard Associated with The Contamination of Lake Calumet, Cook County Illinois by Philippe Ross and Michael E. Henebry, Illinois Natural History Survey, and James Bruno Risatti, Illinois State Geological Survey FY'87.

The goal of this project is to evaluate the extent of contamination in Lake Calumet by physical, chemical and biological methods. The dispersal and concentration of contaminants is being determined by intensive sampling. Ground water seepage studies and soil core analyses are also being used to detect actual sources of contaminants in the lake. Samples of aquatic macrophytes are being examined for evidence of bioaccumulation of heavy metals.

A battery of bioassays (MICROTOX, algal photosynthesis, and protozoan community structure) will indicate whether observed levels of contaminants actually are toxic in the mixtures in which they occur. Multivariate statistical methods will be used to search for predictive relationships between levels of contamination and levels of toxic response.

The capacity of natural sediment microorganisms to degrade organic contaminants is also being studied in laboratory experiments with sediment collected from the lake. The researchers are attempting to isolate the species or consortia responsible for degradation with a view towards possible enrichment to accelerate beneficial natural processes.

The Feasibility of Ion Exchange as an Appropriate Self-Contained Waste Minimization Process for the Electroplating Industry by Center for Neighborhood Technology (FY87,88).

Metal finishing, a critical service industry for all basic manufacturing that involves metals, is characterized by many small job shops. Unfortunately, stricter EPA regulation of hazardous waste disposal methods is making it difficult for many of these shops to remain in business.

A goal of this project is to determine whether an innovative ion exchange pretreatment system is an effective to minimize hazardous waste generation and reduce the disposal problems of these small shops. In addition, the potential for resource recycling from exchange column spent regenerant is being investigated.

Facility Waste Reduction Review by Van Leer, Inc. (FY'87, 88)

Van Leer Containers, Inc. has experienced a combination of rising costs for disposal of hazardous wastes and a degree of difficulty in having these wastes accepted by treatment firms in the form they have been generated. This study, which has been contracted by Chemical Waste Management, Inc., will review each waste generating process of the company and set forth alternatives to the present procedures, reducing costs through minimization measures.

A final report setting forth alternatives to eliminate, reduce or more efficiently manage each waste stream will culminate the study.

Treatment Disposal and Remediation Methods

Solute Effects in Aquifer Cleanup/Hazardous Waste Treatment by Oxy-radical Processes by Gary S. Peyton, Illinois State Water Survey. FY'87.

Ground water that has been contaminated by improper disposal of organic chemicals is usually cleaned up either by air stripping or granular activated carbon adsorption, both of which still leave a pollution problem when treatment is completed.

Oxy-radical processes have been shown to be powerful methods for destroying organic compounds in water. Photolytic ozonation, in particular, has been proven effective for the complete conversion of organic compounds to carbon dioxide and water, organochlorine to chloride, etc. Some solutes present in ground water, however, are known hydroxyl radical scavengers and may interfere with treatment, if present in high concentrations. On the other hand, the scavenging products, radical anions, are known to react preferentially with some organic compounds.

In this study, researchers will investigate the severity of natural solute interference/enhancement, determine concentration ranges in which the effects become dominant upon the kinetics of oxy-radical treatment processes, and identify classes of compounds for which treatment reactions may actually be enhanced by the presence of such solutes. The study will help remove barriers to actual field trials of photolytic ozonation for ground-water cleanup. It will also be important in the design of in-plant hazardous waste treatment processes that use oxy-radical processes.

Spray Dryer Spent Sorbent: Hazardous Waste Fixating and Cementitious Properties by R. L. Berger, University of Illinois. FY'87.

The focus of this research is on the use of the by-products of spray dryers used in flue gas desulfurization technologies. Spray dryers are gaining in popularity because, unlike a wet scrubber, the by-product produced is a dry powder instead of a sludge. This makes disposal less costly.

The aim of this research is to develop a use for spray dryer wastes from utilities using Illinois Basin coal. Two utilization schemes are considered: use as a low grade cement for possible highway construction and use in hazardous waste disposal as a fixating material. Blends of spent sorbent, flyash, water, and cement or lime that may be suitable for use as a low grade cement will be investigated. The most promising mixes then will be characterized to determine the compounds responsible for their strength. The inorganic hazardous waste fixating potential of different blends will be tested and the compounds responsible for their fixation quality will be identified. These technologies, once refined, could provide new treatment options for industry.

Central Recovery Facility for Electroplating Wastes by Huff & Huff, Inc. FY'86-87.

Since new regulations for treatment of wastes from electroplating and metal finishing are soon to go into effect the state of Illinois is assessing the feasibility of the implementation of a Central Recovery Facility to remove and recycle metals from sludges and wastewaters from affected industries. HWRIC plans to (jointly with the Energy and Environmental Affairs division of ENR fund) a study designed to characterize the needs to the metal finishing and electroplating industry in the Chicago area and to analyze the economic feasibility of and interest in such a facility.

In-Situ Bioreclamation of Contaminated Groundwater by Bruce E. Rittmann, and Albert Valocchi, University of Illinois Urbana-Champaign. FY'86-88.

Contamination of ground water by hazardous organic materials has led to the need for efficient and effective techniques for aquifer restoration. In-situ biological degradation is being proposed as a promising alternative for aquifer restoration; however, to date, in-situ bioreclamation designs are planned on an ad-hoc basis without realistic consideration of biodegradation kinetics and ground water hydraulics.

The goal of this project is the development, experimental evaluation, and demonstration of a predictive modeling approach that combines realistic phenomena for biofilm degradation and ground water hydraulics, and that is suited to in-situ bioreclamation schemes. The research methodology involves a combination of laboratory experiments and mathematical modeling.

In-Situ Aquifer Reclamation by Chemical Means: A Feasibility Study by Gary S. Peyton, Illinois State Water Survey. FY'86.

Cleanup of ground water contaminated by organic chemicals that adsorb to aquifer solids may require decades if the water is pumped to the surface to be treated by conventional technologies. In situ treatment means treatment of the contaminant while still in place in the aquifer, and thus takes place at the rate at which the treatment can be transported to the contaminant. Although in situ biotic processes appear promising in

many aquifer reclamation applications, chemical in situ reclamation using free radical processes represents a complementary and, in some respects, more general method of destroying organic contaminants in aquifers.

This study has demonstrated that chemical in situ aquifer reclamation can be feasible in at least some situations. In one experiment, 58 ppm (in the pore water) of benzene, used as the model contaminant, was 62% destroyed after two months. Reactive free radicals were generated from more stable reagents which can be dissolved in water and pumped to the region of contamination. The rate of generation of free radicals was not predictable from batch solution kinetic studies, but was accelerated, apparently due to the presence of promoter substances formed in the reaction of free radicals with soil material. The presence of 50 ppm alkalinity had no detrimental effect on the process.

Feasibility of Land Application of Soils Contaminated with Pesticide Waste as a Remediation Practice by Allan S. Felsot, Illinois Natural History Survey with Rex A. Liebl and Thomas J. Bicki, University of Illinois. FY'86-87.

This project is evaluating the feasibility as a remediation practice of land-applying pesticide-contaminated soils resulting from spills or rinsing operations at agrochemical retail outlets. Studies are being conducted adjacent to the Galesville Chemical Co., where pesticides originating from a highly contaminated wastewater discharge site are believed responsible for contamination of well water and drainage ditches in the surrounding community.

Soils from the discharge site were excavated and applied to corn and soybean plots on adjacent farm land. Pesticide dissipation and translocation, crop phytotoxicity, and residues in grain are being determined to assess the feasibility of the proposed remediation method. Different amounts of contaminated soil were applied to determine the maximum amount that can be land-treated without causing injury to crops or illegal pesticide residues in harvested corn and soybeans. Monitoring wells were installed in plots receiving the highest amounts of contaminated soil to determine the potential for pesticide translocation to ground water.

Groundwater Impact Assessment of Contaminant Migration Through Typical Surficial Geologic Sequences of Illinois" by Bruce Hensel, Illinois Geological Survey, FY'87.

One of the greatest tasks currently facing those responsible for protecting Illinois groundwater resources is to assess the potential hazard that new or existing waste disposal sites pose to drinking water supplies. By evaluating the geological characteristics of sites, those that are most susceptible to groundwater contamination from landfills can be avoided. The objective of this current study is to quantitatively assess the susceptibility of fourteen surficial geologic sequences to contamination from different designs of hazardous waste landfills. This assessment will be based on models of the mobility of several hazardous and non-hazardous substances through the landfill liners and underlying soil deposits.

Sunlight-Riboflavin Decontamination of Groundwater Containing Agriculture by Richard Larson, University of Illinois, FY'87, 88.

The problem of toxic chemicals finding their way into groundwater supplies is growing at an increasing rate. Pesticides and herbicides are an especially large part of this problem. Many subsurface waters have been found to contain measurable levels of biocides such as atrazine and aldicarb.

The purpose of this research is to determine whether treatment of groundwaters containing organic chemicals related to commonly used herbicides and insecticides can be successfully carried out using a combination of sunlight and the naturally occurring

photosensitizers, riboflavin, and methylene blue. Researchers are using carefully controlled laboratory experiments to measure the rates of reactions under various operational conditions and assessing the cost effectiveness of this approach.

Risk Assessment and Policy Analysis

Development of Hazardous Waste Management model for Illinois by Margo Levine of Temple, Barker & Sloan, Inc., Lexington, Massachusetts. FY'87.

The objective of this study is to develop an understanding of the hazardous waste system in Illinois. It will pull together the following information: flows of waste within Illinois; flows to and from the state; types and volumes of waste generated; industries generating the waste; location of generation; waste handling methods; and location of handling. The project will also provide a framework for analyzing the effects of hazardous comparative costs and risks of alternative hazardous waste handling strategies.

Extrapolation of Toxicological Data to Human Health Effects by Gary Johnson and Michael Plewa, Institute for Environmental Studies, University of Illinois. FY'86-88.

A method is needed for predicting the effects of chemical compounds on humans based on tests on lower organisms. The method proposed in this project involves assigning a "radiation equivalent" to a chemical compound or complex mixture. This approach is desirable since gamma radiation effects on humans are known.

The researchers are establishing, for each of three organisms (corn, a yeast and a bacteria), the "radiation equivalent" of a particular compound. For example, it has been established that for corn, one rad of gamma radiation is equivalent to 0.03 micromoles of ethylmethane-sulfonate (EMS) in terms of mutations caused. They will then see if, knowing the radiation equivalent of a given compound on one test organism, they can predict the effects on the other two test organisms. The basis of this extrapolation will be DNA content. (Corn has the highest DNA content, followed by yeast and bacteria.) If extrapolations can be made among the three test organisms on this basis, the researchers will have confidence in extrapolating results to humans on the same basis. In this way, effects on humans could be accurately predicted from simple tests on lower organisms. Such tests could eventually provide the basis for an alternative to or supplement chemical constituent monitoring.

**Taxing Hazardous Waste by Kenneth W. Costello, Dept. of Energy and Natural Resources.
FY'85. (Project Number 007b)**

This investigation, a part of the Special Waste study page of the appendix, outlines some of the issues involved in modifying the hazardous waste fee or tax structure in Illinois. One of these is the possibility of basing fees on the "degree of hazard" associated with a waste stream. This study focuses on the major factors that policy makers should take into account in considering a hazardous waste tax. The most important of these, the effect on controlling land disposal practices at a more socially acceptable level, is examined in detail.

The conclusions are that although a waste-end tax, such as the one Illinois now has, is potentially a deterrent to landfilling, current fees are too low to serve that purpose. Since a ban on landfilling of hazardous wastes is scheduled to go into effect in 1987, a restructured waste-end tax in Illinois may at best function as an interim strategy. Any tax based on "degree of hazard" of a waste stream would also have to account for the disposal method.

Assigning a Relative Degree of Hazard Ranking to Illinois Waste Streams by Michael Plewa, et. al., Institute for Environmental Studies, University of Illinois. FY'86.

In FY'85, the "Special Waste Categorization Study" provided a method for determining the relative degree of hazard of a waste stream (high, medium, low or negligible). The input received from various parties suggested that the next step should be a categorization of a large number of waste streams to determine how well the system operates in practice.

In this study, the degree of hazard system was computerized, a database of appropriate chemicals compiled, and a statistically significant sample of Illinois hazardous and special, non-hazardous waste streams were evaluated. The Illinois Environmental Protection Agency's database on waste stream constituents was used. The researchers concluded that it is feasible to implement the methodology on a large scale if appropriate waste stream information can be obtained.

Refining the "Degree of Hazard Ranking Methodology for Illinois Industrial Waste Streams by Roger Minear and Michael Plewa, University of Illinois. FY'87-88.

In FY'86, Dr. Michael Plewa and his colleagues, in their "Assigning a Degree of Hazard Ranking to Illinois Waste Streams," computerized the degree of hazard methodology and evaluated a statistically significant sample of Illinois hazardous and nonhazardous waste streams to determine their degree of hazard.

The purpose of this study is to improve the toxicological basis and other selected aspects of the methodology. In addition, the researchers will make the computer ranking system interactive and develop a formal procedure to employ national toxicology and chemical data bases for the periodic revision of the toxicity data base that was constructed in the previous study.

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